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THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. *In:* SCHULTZE, L. *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika* 4: 269–270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* 16: 269–270.

(*continued inside back cover*)

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CRETACEOUS FAUNAS FROM ZULULAND AND NATAL, SOUTH AFRICA THE AMMONITE FAMILY KOSSMATICERATIDAE SPATH, 1922

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&
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Cape Town Kaapstad

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CRETACEOUS FAUNAS FROM ZULULAND AND NATAL, SOUTH AFRICA
THE AMMONITE FAMILY KOSSMATICERATIDAE SPATH, 1922

By

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&

Herbert Christian Klinger

South African Museum, Cape Town

(With 34 figures)

[*MS accepted 27 June 1984*]

ABSTRACT

The occurrence of members of the family Kossmaticeratidae in South Africa is well known, and belies the rarity of the group.

The following are described below: *Marshallites* cf. *cumshewaensis* (Whiteaves, 1884), which is new to South Africa and only the second record of the genus in the Southern Hemisphere; *Kossmaticeras (Kossmaticeras) theobaldianum* (Stoliczka, 1865) and varieties, *K. (K.) sparsicostatum* (Kossmat, 1897), *K. (K.) sakondryense* Collignon, 1954, *K. (K.) jonesi* Collignon, 1965, *K. (K.) jeletzkyi* Collignon, 1965, *K. (Natalites) africanus* (van Hoepen, 1920) of which *K. (N.) natalensis* (Spath, 1922) is a synonym, *K. (N.) faku* (van Hoepen, 1920) of which *K. (N.) acuticostatus* (Spath, 1922) is a synonym, *K. (N.) similis* Spath, 1921, *K. (N.) elegans* sp. nov., *K. (Karapadites) karapadensis* (Kossmat, 1897), *K. (K.)* cf. *madrasinus* (Stoliczka, 1865), *K. (K.) besairiei* Collignon, 1954, *K. (K.) planissimus* Collignon, 1966, *Maorites* cf. *subtilistriatus* Collignon, 1954 (the first record of the genus from South Africa), *Gunnarites antarcticus* (Weller, 1903) and *G. kalika* (Stoliczka, 1865).

CONTENTS

INTRODUCTION

The Kossmaticeratidae are a highly distinctive family of Desmoceratacеae that have their probable origins in the late Aptian and range to the Maastrichtian.

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The distinctive features of the group are the ornament of fine to coarse, often dense ribs (sometimes associated with tubercles), which are interrupted and often truncated by oblique constrictions. The group is best known from around the Indian and Pacific oceans, especially in southern India, Madagascar, Japan, and New Zealand, although it ranges widely. Its presence in South Africa has been well known since the publications of Woods (1906), Van Hoepen (1920, 1921) and Spath (1921*a*, 1921*b*, 1922) but in contrast to other groups described by the present authors, the previously published records give an unbalanced view of its occurrence, for it is rare.

Extensive reviews of the Kossmaticeratidae are given by Collignon (1954, 1955), where all species described up to that date are listed. Important new faunas are described by Collignon in the *Atlas* (1964, 1965*a*, 1965*b*, 1966, 1969, 1970, 1971) and by Henderson (1970). In view of the scarcity of kossmaticeratids in South Africa, which adds nothing to our knowledge of the evolution of the group—although their presence clarifies stratigraphic and geographic distributions—no general discussion is provided below.

LOCATION OF SPECIMENS

The following abbreviations are used to indicate the repositories of the material studied:

BMNH	British Museum (Natural History)
DM	Durban Museum
GSC	Geological Survey, Canada, Ottawa
NMB	National Museum, Bloemfontein (on permanent loan to SAM)
SAM	South African Museum, Cape Town
SAS	South African Geological Survey, Pretoria
TM	Transvaal Museum
UD	University of Natal, Durban; Geology Department Collection.
YPM	Peabody Museum, Yale University.

FIELD LOCALITIES

Details of localities mentioned in the text are given by Kennedy & Klinger (1975); fuller descriptions of sections are deposited in the Palaeontology Department of the British Museum (Natural History), London; Geological Survey, Pretoria; and South African Museum, Cape Town.

STRATIGRAPHY

Kennedy & Klinger (1975) proposed a series of working divisions of the Barremian to Maastrichtian of Zululand, deferring erection of a detailed biozonation until revision of the ammonite faunas was completed. At the same time they admitted that the stage divisions recognized were 'local' only, because of problems of interpretation of these stages in the type areas of western Europe

and correlation from the type areas to southern Africa. Recent work has shown that, in the case of the Campanian–Maastrichtian boundary, the limit has been drawn too high in the sequence. Division Campanian IV, from which *Saghalinites cala* (Forbes), *Pachydiscus (Pachydiscus), Gunnarites antarcticus* (Weller), *Nostoceras* sp. and *Pachydiscus (Neodesmoceras)* were recorded, is Lower Maastrichtian. The *Pachydiscus (Pachydiscus)* is in fact *P. (P.) neubergicus* (Hauer), an exclusively Maastrichtian species, while the *Pachydiscus (Neodesmoceras)* is *P. (N.) mokotibensis* Collignon, also exclusively Maastrichtian. The succeeding Campanian V is thus also Maastrichtian, as is confirmed by the presence of a specimen of *Eubaculites latecarinatus* (Brunnschweiler) at this horizon at locality 118. The authors will continue to use the existing scheme modified to:
Maastrichtian a (= 'Campanian' IV) and Maastrichtian b (= 'Campanian' V).

DIMENSIONS OF SPECIMENS

All dimensions given below are in millimetres:
D = diameter, Wb = whorl breadth, Wh = whorl height, U = umbilical diameter; *c* and *ic* refer to costal and intercostal measurements respectively.

Figures in parentheses are dimensions as a percentage of the total diameter.

SUTURE TERMINOLOGY

The suture terminology of Wedekind (1916), reviewed by Kullmann & Wiedmann (1970) is followed here:
I = internal lobe, U = umbilical lobe, L = lateral lobe, E = external lobe.

SYSTEMATIC PALAEONTOLOGY

Superfamily DESMOCERATACEAE Zittel, 1895

Family **Kossmaticeratidae** Spath, 1922

Subfamily Marshallitinae Matsumoto, 1955

Genus *Marshallites* Matsumoto, 1955

Type species

Marshallites compressus Matsumoto, 1955, by original designation.

Marshallites cf. *cumshewaensis* (Whiteaves, 1884)

Fig. 1B–C

Compare

Haploceras cumshewaensis Whiteaves, 1884: 208, pl. 24 (fig. 1).
Holcodiscoides cumshewaensis (Whiteaves): Imlay & Reeside, 1954: 230.
Marshallites cumshewaensis (Whiteaves): Matsumoto, 1959: 63, pl. 17 (figs 1–4), pl. 19 (fig. 2), pl. 20 (fig. 2), text-fig. 10. McLearn, 1972: 53, pl. 3 (figs 1–2).

Holotype

By monotypy: GSC 4973, from the north shore of Cumshewa Inlet, British Columbia, Canada.

Material

SAS Z1088, from locality 145, degraded bluffs on eastern side of the Msunduzi River, Zululand, St. Lucia Formation, Coniacian II.

Description

The specimen retains part of the body chamber and some recrystallized shell material; the maximum preserved diameter is 39,9 mm. Coiling is moderately involute; the whorls are compressed, with the greatest breadth just below mid-flank. The sides are gently inflated, and converge to abruptly rounded ventrolateral shoulders and a distinctly flattened venter.

Ornament consists of abundant fine, dense prorsiradiate ribs that arise in bunches from weak umbilical bullae. They sweep forward and are straight across the inner flank, flex gently backward at mid-flank and are convex, sweeping forward over the ventrolateral shoulder to cross the venter in a broad convexity. They branch at or about mid-flank, and there are occasional intercalated short ribs so that there are many more ribs than umbilical bullae. There are numerous flexuous, prorsiradiate constrictions, associated with adapical and adapertural collar ribs that are slightly stronger than the remaining ribs and oblique to the ribs behind them.

The sutures are not exposed.

Discussion

The specimen closely resembles specimens of *Marshallites cumshewaensis* figured by Matsumoto (1959). Of other species referred to this genus, *M. compressus* Matsumoto (1955: 123, pl. 8 (figs 1–2), text-figs 1–2) is more evolute and compressed, while *M. compressus puzosioides* Matsumoto (1955: 125, pl. 8 (figs 3–4)) has extremely fine ornament. *Marshallites olcostephanoides* Matsumoto (1955: 129, pl. 8 (figs 5–7), text-fig. 4) is, as the name suggests, *Olcostephanus*-like, evolute and with a whorl breadth to height ratio of between 0,85 and 1,2; the flanks rounded and merging with the venter rather flattened with a distinct ventrolateral shoulder.

Marshallites columbianus McLearn (1972: 54, pl. 3 (fig. 3)) has much coarser ribs with a more robust whorl. *Marshallites papillatus* (Stoliczka) (1865: 159, pl. 77 (figs 7–8)) is more evolute, with a less compressed whorl, coarser ribs and many strong constrictions that are far more prominent than in our species.

Occurrence

Marshallites cumshewaensis is an Albian to Cenomanian species, best known from British Columbia and Alaska. It has not been previously recorded in the

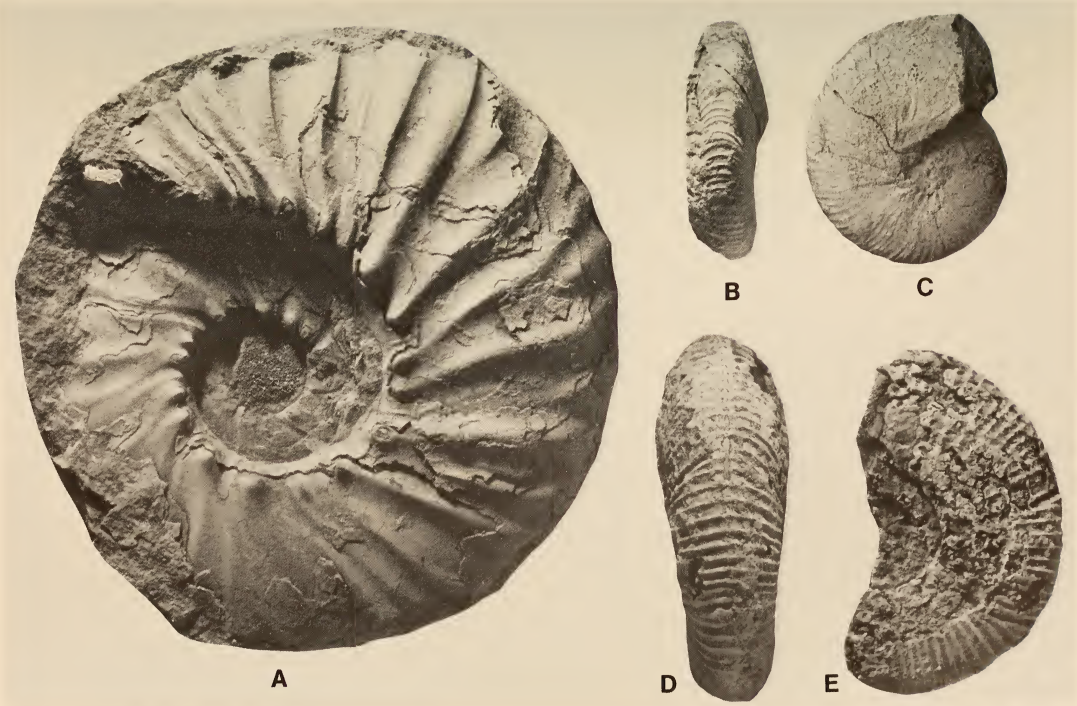


Fig. 1. A. *Kossmaticeras (Karapadites) planissimus* Collignon, 1965; SAS H126A/3 from locality 105, Zululand. B–C. *Marshallites* cf. *cumshewaensis* (Whiteaves, 1884) from the same locality as A. D–E. *Kossmaticeras (Kossmaticeras) theobaldianum theobaldianum* (Stoliczka, 1865); NMB D943, from the Skoenberg area of Zululand. All × 1.

Southern Hemisphere, although the genus may occur in New Zealand (Henderson 1970).

Subfamily Kossmaticeratinae Spath, 1922

Genus *Kossmaticeras* de Grossouvre, 1901

Subgenus *Kossmaticeras* de Grossouvre, 1901

Type species

Ammonites theobaldianus Stoliczka, 1865, by original designation of De Grossouvre (1901).

Kossmaticeras (Kossmaticeras) theobaldianum theobaldianum Stoliczka, 1865

Figs 1D–E, 2A–E

Kossmaticeras theobaldi Stoliczka: Collignon, 1955: 20, pl. 1 (figs 2–3), pl. 2 (fig. 1) (with synonymy); 1965*b*: 24, pl. 423 (figs 1753–1755).
Kossmaticeras theobaldianum (Kossmat): Sastry, Rao & Mamgain, 1968: pl. 4 (figs 1–2).

Material

NMB D943, SAM–4909 (the original of *Kossmaticeras (Madrasites) bhavani* Spath (*non* Stoliczka), 1921*a*: 299, pl. 24 (fig. 8)), UD 45A–B, St. Lucia Formation, Coniacian I, the Skoenberg region, Zululand. BMNH C83329 from locality 63, also on the Skoenberg, St. Lucia Formation, Coniacian I.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAM–4909	64,1	22,3(34,7)	23,2(36,1)	0,96	22,0(34,3)
SAS D943	60,0	21,7(36,1)	21,0(35,0)	1,03	21,0(35,0)

Description

All the specimens available retain variably corroded, recrystallized shell; all are septate throughout.

The coiling is evolute (less than half the previous whorl is covered) and the whorls expand slowly. The umbilicus is of moderate breadth (around 35 per cent of the diameter) and depth, with a flattened wall at approximately 90 degrees to the flanks of the preceding whorl. The umbilical shoulder is narrowly rounded, the whorl section slightly, if at all, compressed (whorl breadth to height ratio varies between 1,03 and 0,96), with somewhat flattened, rounded convergent flanks and a broadly rounded venter, the greatest breadth being at or a little outside the umbilical shoulder. SAM–4909 has approximately 40 primary ribs per whorl at a diameter of 40 mm. The ribs arise singly or in pairs on the umbilical shoulder where they are narrow and sharp, with occasional incipient bullae. They are narrower than the interspaces, prorsiradiate and straight to gently flexed across the flanks, crossing the venter in a broad shallow convexity. They either

Fig. 2. A–E. *Kossmaticeras (Kossmaticeras) theobaldianum theobaldianum* (Stoliczka, 1865). A–B, D–E. UD 45A–B (ex M. R. Cooper Coll.), from the Coniacian of the Skoenberg, Zululand. C. SAM–4909, the original of Spath (1921*a*: 299, pl. 24 (fig. 8)), from the same area. All × 1.

branch at various points on the flank or are accompanied by shorter intercalated ribs that also arise at various points on the flank, so that there are approximately twice as many ribs per whorl over the venter as there are at the umbilical shoulder. There are periodic constrictions, four or five per whorl; narrow and deep, they are flanked by strengthened collar-ribs which usually branch twice.

Discussion

Evolute coiling and dense, wire-like ribbing characterize this species, and the specimens discussed here closely recall the Indian type material. A number of varieties have been attached to this species: *Kossmaticeras (Kossmaticeras) theobaldianum* var. *crassicostata* Collignon, 1954, discussed fully below, differs from typical forms in having fewer and more distant, coarse ribs, and is clearly no more than a variant. In contrast *Kossmaticeras theobaldianum paucicostatum* Matsumoto, 1955 (p. 147, pl. 9 (figs 1–2)), a paratype of which is illustrated here as Figure 5A–B, has very distant, broad ribs and a rather massive whorl, and recalls the *K. (K.) sparsicostatum* (Kossmat, 1897)–*K. (K.) pachystoma* (Kossmat, 1897) group, the coarse ribbing of all of which distinguish them from *K. (K.) theobaldianum theobaldianum. Kossmaticeras (K.) japonicum* Matsumoto, 1955 (p. 150, pl. 9 (fig. 3)), the holotype of which is reillustrated here as Figure 5C–F, has distinctive low, broad, crowded ribs quite unlike the wiry ribbing of the present form. *Kossmaticeras (K.) recurrens* (Kossmat, 1897) (p. 37 (144), pl. 7 (18) (figs 2–3)) has numerous fine ribs, arising at the umbilicus without bullae, dichotomously branched on the flanks and crossing the venter with a marked forward projection; there are five constrictions per whorl. *Kossmaticeras (K.) manasoaense* Collignon, 1954 (p. 22, pl. 5 (fig. 1)) (see Fig. 11A–B) and *K. (K.) sakondryense* Collignon, 1954 (p. 22, pl. 5 (figs 2–6) (see Fig. 8C–D) are more compressed, narrowly umbilicate and feebly ribbed species, while *K. (K.) pavlowskyi* Collignon, 1954 (p. 24, pl. 2 (figs 2–3)) (see Fig. 8A–B) is higher-whorled with fine flexuous ribs that are bi- and triplicate at mid-flank, so that there are three times as many ribs on the venter as at the umbilicus. *Kossmaticeras (K.) virgatitiforme* Collignon, 1965*b* (p. 27, pl. 425 (fig. 1763)) is characterized by a distinctive division of ribs into bundles of three, with additional intercalatories. *Kossmaticeras (K.) jonesi* Collignon, 1965*b* (p. 29, pl. 426 (figs 1764–1765)) is a flat-sided species, rather bluntly ribbed, and is, according to Collignon, especially characterized by shallow, progressively widening constrictions, four per whorl. *Kossmaticeras (K.) jeletzkyi* Collignon, 1965*b* (p. 29, pl. 426 (fig. 1766)) was particularly characterized by the presence of seven constrictions per whorl.

Occurrence

Kossmaticeras (K.) theobaldianum theobaldianum is restricted to the lowest division of the Coniacian recognized in Zululand, and occurs only in the Skoenberg region. It was originally described from the Coniacian of southern India, and is also recorded from the Middle Coniacian of Madagascar.

Kossmaticeras (Kossmaticeras) theobaldianum crassicostata Collignon, 1954

Figs 3–4

non *Ammonites theobaldianus* Stoliczka, 1865: 161 (pars), pl. 78 (fig. 3–3a only).
non *Holcodiscus theobaldianus* Stoliczka, Grobberippte Varietät: Kossmat, 1897: 36 (143).
Kossmaticeras theobaldi Stoliczka, var. *crassicostata* Collignon, 1954: 17, pl. 1 (fig. 3), pl. 2 (fig. 1); 1955: 21, pl. 1 (fig. 3), pl. 2 (fig. 1); 1965*b*: 24, pl. 423 (fig. 1756), pl. 424 (fig. 1757).

Type

Holotype by original designation, the specimen figured by Collignon (1954, pl. 2 (fig. 1)) from the Coniacian of Ampozalaoka, Madagascar.

Material

BMNH C83330, from locality 13, hill slopes below Riverview Compound, 750 m north of the sugar-cane railway bridge across the Mfolozi, south of Mtubatuba, Zululand, St. Lucia Formation, Coniacian II.

Description

The specimen is a beautifully preserved, wholly septate, fragmentary individual with an estimated original diameter of 50 mm. It retains well-preserved recrystallized shell.

Coiling is moderatedly evolute, less than half the previous whorl being concealed, with a fairly deep umbilicus that comprises an estimated 30 per cent of the total diameter. The whorl section is equidimensional in section. The greatest breadth is at the umbilical bulla, the flanks are broadly rounded or flattened, merging with a more narrowly rounded venter.

Strong umbilical bullae give rise to single or, more rarely, to pairs of primary ribs. These are narrow and distant, prorsiradiate, passing straight across the inner flank, thereafter flexing backward across the remainder of the flank and passing

Fig. 3. *Kossmaticeras (Kossmaticeras) theobaldianum crassicostata* Collignon, 1954; BMNH C83330, from locality 13, Zululand, Coniacian II. × 1.

Fig. 4. *Kossmaticeras (Kossmaticeras) theobaldianum crassicostata* Collignon, 1954; the holotype of the variety, the original of Collignon (1954: 17, pl. 2 (fig 1–1b), from the Lower Coniacian of Ampozalaoka (Menabe), Madagascar. × 1.

straight across the venter. Shorter intercalated ribs, arising on the ventrolateral shoulder, alternate regularly with the primary ribs.

The constrictions are strongly developed and associated with collar-ribs; the adapical collar is the stronger, arising from an umbilical bulla and branching into three in characteristic virgatotome fashion; the adapertural collar is weaker and simple, and followed by a narrow zone of growth lines. In ventral view the adapical collar forms a much more narrowly rounded peak than the other ribs.

The sutures are not exposed.

Discussion

The specimen closely resembles the inner whorls of the holotype from Madagascar (Fig. 4) but differs from the rather bluntly ribbed specimens from southern India as illustrated by Stoliczka (1865, pl. 127 (figs 2–3)), which we prefer to refer to *Kossmaticeras (K.) theobaldianum paucicostatum*, and regard as transitional to the *K. (K.) sparsicostatum–pachystoma* group, regarding *K. (K.) crassicostata*, with wiry ribs, as closer to the typical form.

Occurrence

Coniacian II of Zululand, Lower (Collignon 1954) or Middle (Collignon 1965*b*) Coniacian of Madagascar.

Kossmaticeras (Kossmaticeras) aff. *theobaldianum crassicostata*
Collignon, 1954
Fig. 6F

Compare

Kossmaticeras theobaldi Stoliczka, var. *crassicostata* Collignon, 1954: 17, pl. 1 (fig. 3), pl. 2 (fig. 1).

Material

SAS Z1063, from the Skoenberg area, St. Lucia Formation, Coniacian I.

Discussion

The specimen is a fragment only, septate throughout, with recrystallized and somewhat corroded test. The style of ornament is closely similar to that shown by *Kossmaticeras theobaldianum crassicostata*, described above, but the ribs are sparser, coarser, with wider interspaces and a greater tendency to branch at or about mid-flank, with fewer intercalatories and more prominent constrictions.

Occurrence

Coniacian I of Zululand.

Kossmaticeras (Kossmaticeras) theobaldianum paucicostatum Matsumoto, 1955

Figs 5A–B, 6G–H

Ammonites theobaldianus Stoliczka, 1865: 161 (pars), pl. 78 (fig. 3–3a only).
Holcodiscus theobaldianus Stoliczka, Grobberippte Varietät: Kossmat, 1897: 36 (143).
Kossmaticeras theobaldianum paucicostatum Matsumoto, 1955: 147, pl. 9 (figs 1–2).

Type

The holotype is the original of Matsumoto (1955, pl. 9 (fig. 2)) from the Coniacian of the Bannosawa, a tributary of the Ikushumbets, Hokkaido, Japan.

Material

SAS Z999, from locality 93, hill slopes on either side of Lots H101–102, ESE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian II.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*	*Ribs*
SAS Z999	67,5	21,7(31,1)	26,1(38,6)	0,86	21,0(31,1)	60

Description

The specimen is a somewhat worn internal mould retaining traces of shell; two-thirds of the last whorl is body chamber but it is not clear whether or not the specimen is adult.

The coiling is moderately evolute, the shallow umbilicus comprising 31 per cent of the diameter. The low umbilical wall is rounded. There are 21–22 umbilical bullae of variable strength on the outer whorl. These give rise to one or two strong, prorsiradiate primary ribs, some of which bifurcate, while shorter intercalated ribs arise on the outer flank, giving a total of 60 per whorl. They pass straight across the inner flank and are projected forward across the outer flank and ventrolateral shoulders, crossing the venter with a shallow convexity. There are six or seven strong, deep constrictions per whorl. These are prorsiradiate, passing straight across the flanks and strongly projected over the venter, which they cross with a narrower convexity than that shown by the ribs. The adapical collar is bullate, strong, branches in two at the ventrolateral shoulder, the adapertural branch dividing into two a second time over the venter. The adapertural collar lacks a bulla, is unbranched, and weaker than the adapical one.

The sutures are not decipherable.

Discussion

A paratype of *Kossmaticeras (K.) theobaldianum paucicostatum* is shown in Figure 5A–B, for comparison with the Zululand specimen, which is somewhat worn. Both have the rather blunt ribbing that, as Matsumoto (1955: 148) noted, suggests affinity to *K. (K.) sparsicostatum*. The Zululand specimen closely resembles Stoliczka's large specimen (1865, pl. 78 (fig. 3–3a)), especially in the form of the ribs and the collars associated with the constrictions. It differs from

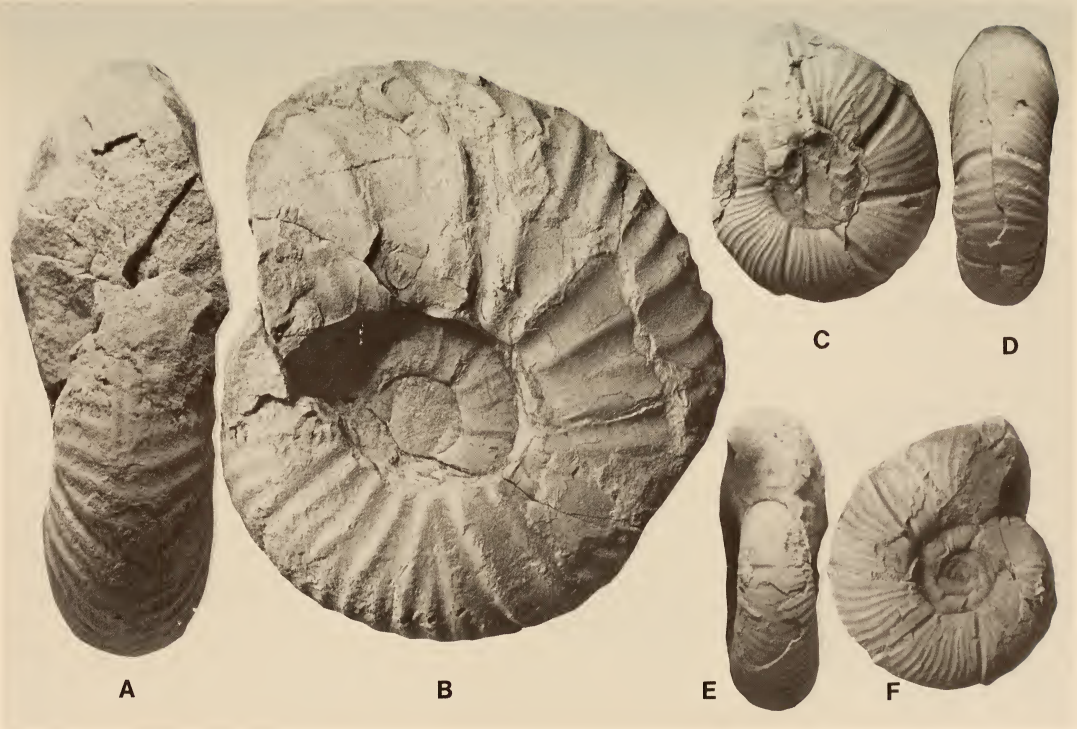
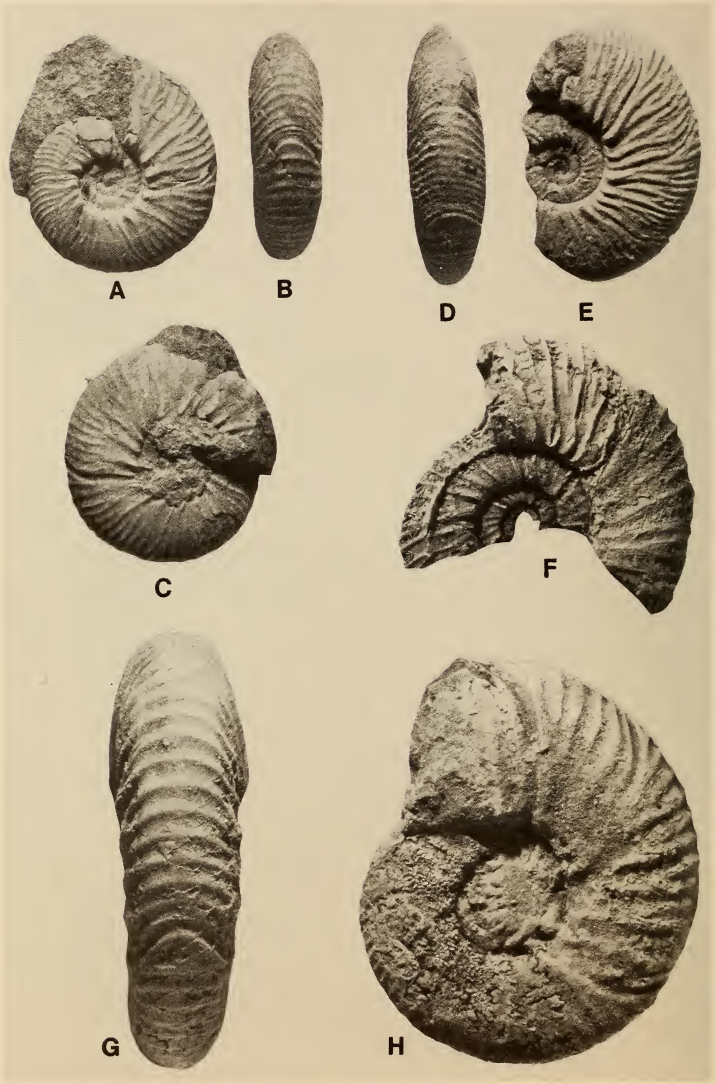


Fig. 5. A–B. *Kossmaticeras (Kossmaticeras) theobaldianum paucicostatum* Matsumoto, 1955; No H74101 in the Kyushu University Collections, a paratype, from the Coniacian of the Ikushumbets, Hokkaido, Japan. C–F. *Kossmaticeras (Kossmaticeras) japonicum* Matsumoto, 1955; the holotype, in the collections of Hokkaido University, from the Bannosawa, a tributary of the Ikushumbets, Hokkaido, Japan. All × 1.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K. (K.) sparsicostatum in having more ribs, and far less striking differentiation into primaries and secondaries, whereas *K. (K.) pachystoma* is most easily distinguished by the inflated shell form and more numerous short ribs.

Occurrence

Coniacian II of Zululand; undifferentiated Coniacian of southern India and of Japan.

Kossmaticeras (Kossmaticeras) sparsicostatum (Kossmat, 1897)

Fig. 7A–E

Ammonites denisonianus Stoliczka, 1865: 133 (pars), pl. 66 (fig. 1 only).
Holcodiscus sparsicostatus Kossmat, 1897: 38 (145), pl. 6 (17) (fig. 5).
Kossmaticeras sparsicostatum Kossmat: Collignon, 1954: 19, pl. 3 (fig. 1), pl. 4 (fig. 1); 1955: 22, pl. 3 (fig. 1), pl. 4 (fig. 1); 1965*b*: 26, pl. 174 (fig. 1758).

Material

SAM–PCZ6395 figured here as Figure 7A–E, presumed to be from locality 72, degraded river cliffs on the Mzinene River, NNE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian III.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAM–PCZ6395	82,0	27,7(33,8)	30,6(37,3)	0,91	28,2(34,4)
at	44,5	14,2(31,9)	17,7(39,8)	0,80	13,7(30,8)

Description

The specimen is a well-preserved internal mould; all but the last quarter whorl is body chamber.

At a diameter of 44,5 mm (Fig. 7A–C) the coiling is moderately involute, 39 per cent of the previous whorl being covered. The umbilicus comprises 30,8 per cent of the diameter and is relatively shallow, with a rounded wall, undercut on the mould. The whorl section is compressed (whorl breadth to height ratio is 0,80) with the greatest breadth at the umbilical bulla. The flanks are flattened and converge slightly to an evenly rounded venter.

There are 20 umbilical bullae of variable strength per whorl, arising as swellings on the umbilical wall. These give rise to single primary ribs that are narrow, prorsiradiate, pass straight across the inner flank, curve backward at mid-flank, where they commonly bifurcate, sweep further back and then forward

Fig. 6 *(facing page)*. A–C. *Kossmaticeras (Kossmaticeras)* sp. cf. *jonesi* Collignon, 1965; SAS Z1587, from locality 92, Zululand, Coniacian II. D–E. *Kossmaticeras (Kossmaticeras) jonesi* Collignon, 1965; SAS H146/7, from locality 13, Zululand, Coniacian II. F. *Kossmaticeras (Kossmaticeras)* aff. *theobaldianum crassicostata* Collignon, 1954; SAS Z1063, from the Skoenberg area, Zululand, Coniacian I. G–H. *Kossmaticeras (Kossmaticeras) theobaldianum paucicostatum* Matsumoto, 1955; SAS Z999, from locality 93, Zululand, Coniacian II. All × 1.

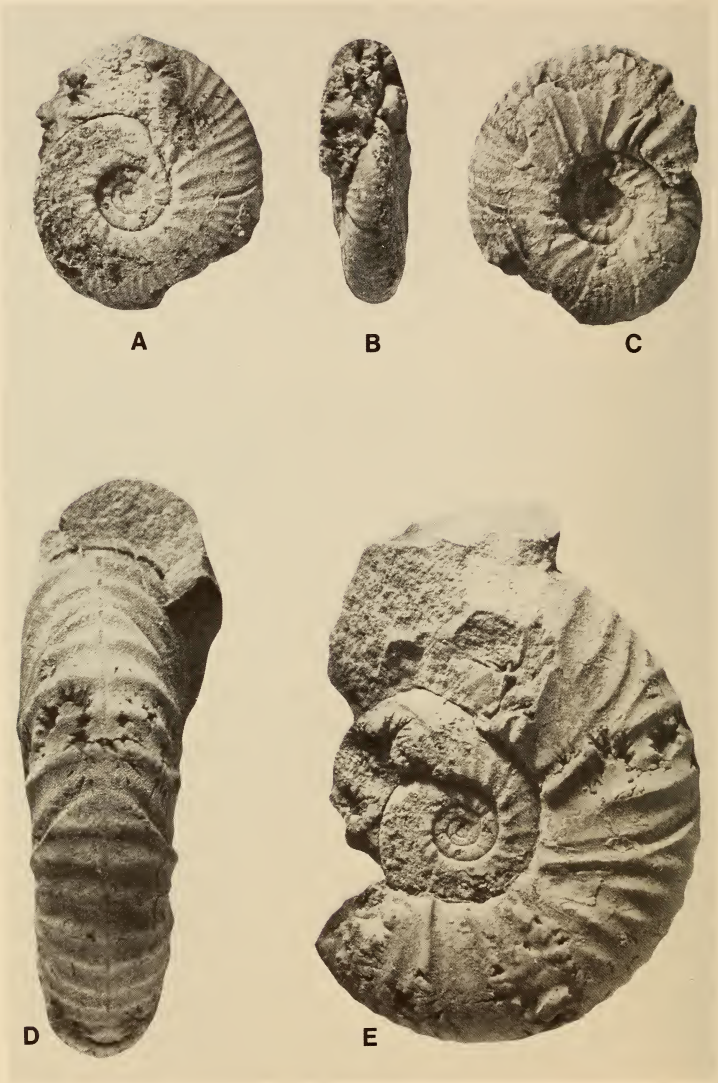


Fig. 7. A–E. *Kossmaticeras (Kossmaticeras) sparsicostatum* (Kossmat, 1897); SAM–PCZ6395, presumably from locality 72, Zululand, Coniacian III. × 1.

to cross the venter in a broad convexity. There are also secondary ribs, inserted low on the flank, giving a total of 65–70 ribs per whorl.

There are seven constrictions per whorl with associated collar-ribs, the adapical collar branches into two or three, the adapertural one is simple and slightly weaker.

On the outer whorl, the cross-section is somewhat broader (whorl breadth to height ratio is 0.91), and the ribbing coarser. Irregular and variably developed umbilical bullae, eight per half whorl, give rise to a primary rib or a pair of ribs, and there are also non-bullate primaries. Some primaries bifurcate at mid-flank and there are also intercalated secondaries, giving a total of 26 ribs per half whorl. There are four constrictions on the last half whorl of the phragmocone. These are deep, broad, prorsiradiate and straight on the flanks and projected over the venter into a narrow convex peak. The adapical collar-rib is strong, arises at a prominent bulla and branches at mid-flank and on the ventrolateral shoulder. The adapertural rib is weaker, and simple.

The suture-line is only partially exposed, is deeply and intricately subdivided, and typical for the genus.

Discussion

The relationship of *Kossmaticeras (K.) sparsicostatum* and *K. (K.) theobaldianum theobaldianum*, *K. (K.) t. crassicostata* and *K. (K.) t. paucicostatum* has been discussed above. The species is close to *K. (K.) pachystoma* (Kossmat) (1897: 39 (146), pl. 7 (18) (fig. 1)), from which it is most easily separated by the compressed as compared to circular cross-section, narrower and rather irregular ribbing.

Occurrence

Coniacian of Zululand, Lower (Collignon 1954) or Middle (Collignon 1965*b*) Coniacian of Madagascar, and undifferentiated Coniacian of southern India.

Kossmaticeras (Kossmaticeras) sakondryense Collignon, 1954

Figs 8C–D, 10A–B

Kossmaticeras (Kossmaticeras) sakondryense Collignon, 1954: 22, pl. 5 (figs 2–5), (fig. 6 = var. *eboroense*); 1955: 22, pl. 5 (figs 2–5), (fig. 6 = var. *eboroense*); 1965*b*: 27, pl. 425 (fig. 1761).

Type

The holotype, by original designation, is the original of Collignon (1954, pl. 5 (fig. 5)), reproduced here as Figure 8C–D, from the Coniacian of the Ravin d'Anjoho, Sakondry Valley, Madagascar.

Material

SAS Z929, from locality 93, hill slopes on either side of boundary between Lots H101–102, ESE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian II.

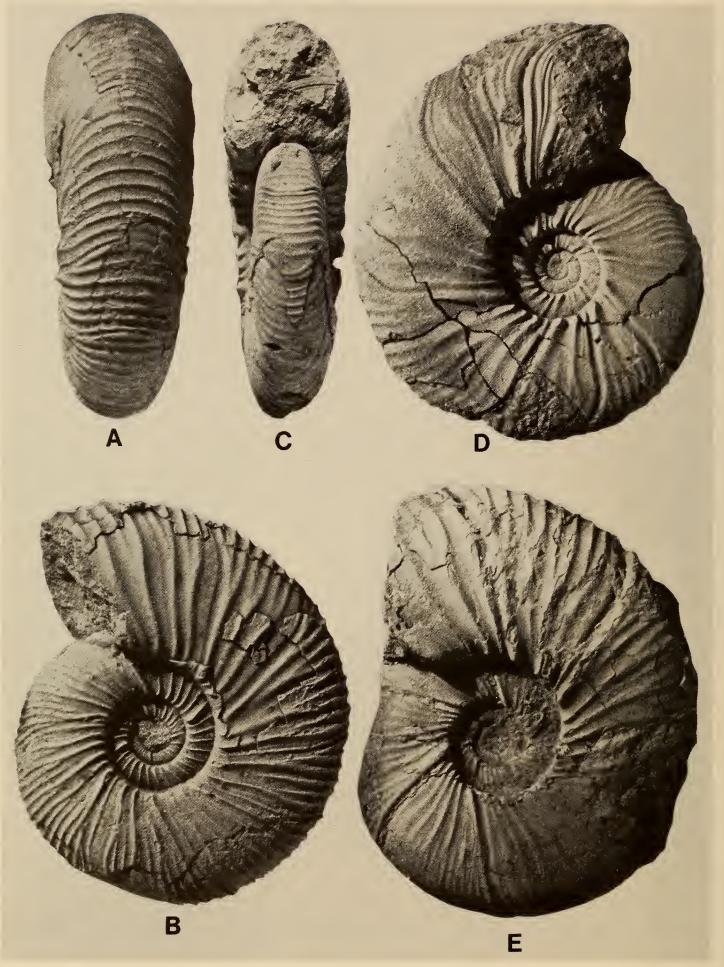


Fig. 8. A–B. *Kossmaticeras (Kossmaticeras) pavlowskyi* Collignon, 1954; a paratype, from the Coniacian of Ampozalaoka (Menabe), Madagascar, the original of Collignon (1954, pl. 2 (fig. 2–2b)). C–D. *Kossmaticeras (Kossmaticeras) sakondryense* Collignon, 1954; the holotype, the original of Collignon (1954, pl. 5 (fig. 5–5b)), from the Coniacian of Sakondry, Madagascar. E. *Kossmaticeras (Kossmaticeras) sakondryense* var. *eboroense* Collignon, 1954; the holotype of the variety, the original of Collignon (1954, pl. 5 (fig. 6)), from the Coniacian of Eboro, Madagascar. All × 1.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z929	72,7(100)	23,5(32,3)	27,5(37,8)	0,85	21,4(29,4)

Description

The specimen is somewhat abraded, in part an internal mould, in part retaining well-preserved aragonitic shell material.

Coiling is moderately involute, with 57 per cent of the previous whorl being covered. The rather shallow umbilicus comprises 29,5 per cent of the diameter.

Fig. 9. *Kossmaticeras (Kossmaticeras) jeletzkyi* Collignon, 1965; SAS D1342, from locality 72, Zululand, Coniacian III. × 1.

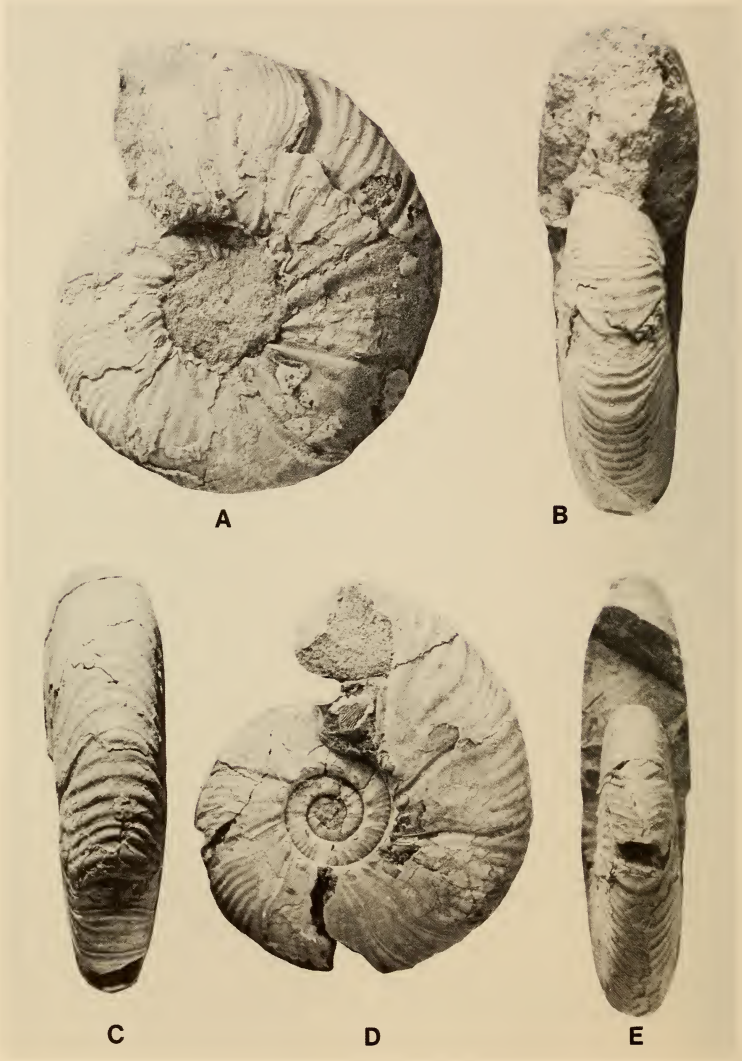


Fig. 10. A–B. *Kossmaticeras (Kossmaticeras) sakondryense* Collignon, 1954; SAS Z929, from locality 93, Zululand, Coniacian II. C–E. *Kossmaticeras (Natalites) elegans* sp. nov.; the holotype, SAS H30/9, from locality 100, Zululand, Santonian I. All × 1.

The whorl section is compressed (whorl breadth to height ratio is 0,85) with the greatest breadth close to the narrowly rounded umbilical shoulder. The sides are flattened, and converge to the rounded ventrolateral shoulders. The venter is somewhat flattened.

Ornament consists of approximately 100 fine ribs; 30 of these arise at small umbilical bullae developed from broad swellings on the umbilical wall. The bullae are fine, comma-shaped, and variable in strength. They give rise to prorsiradiate ribs that pass straight across the sides, bend forward or are gently flexed on the inner flank and bend forward across the outer flank and ventrolateral shoulder to project over the venter in a strong convexity.

These primary ribs branch once or twice on the outer flank and loop across the venter, while there are also shorter intercalated ribs.

There are nine narrow, deep, prorsiradiate constrictions per whorl. These are straight on the inner flank but sweep forward over the venter in a deep convexity on the mould that is scarcely visible when the shell is present. Strengthened collar-ribs flank the constrictions; the adapical collar subdivides across the ventrolateral shoulder to give rise to three or four riblets arranged in a virgatotome pattern.

The sutures are not exposed.

Discussion

Kossmaticeras (K.) sakondryense is a distinctive, compressed, high-whorled, involute and delicately ornamented *K. (Kossmaticeras)*; features which separate it from most other species of the subgenus. There are some similarities to *K. (K.) japonicum* Matsumoto (1955: 150, pl. 9 (fig. 3)) (see Fig. 5C–F), from the Coniacian of Hokkaido and Saghalien, but the Japanese form is less compressed, with lower whorls and coarser ribs with fewer (6–7 versus 9) constrictions per whorl.

Occurrence

Coniacian II of Zululand; Lower (Collignon 1954) or Middle (Collignon 1965*b*) Coniacian of Madagascar.

Kossmaticeras (Kossmaticeras) aff. *sakondryense* Collignon, 1954

Fig. 21A–C

Compare

Kossmaticeras (Kossmaticeras) sakondryense Collignon, 1954; herein, p. 181, Fig. 8C–D.

Material

SAS Z934, from locality 93, hill slopes on either side of boundary of Lots H101–102, ESE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian II.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z934	59,0	18,5(31,3)	25,0(42,3)	0,74	15,3(25,9)

Description and discussion

The specimen is a wholly septate internal mould, and somewhat abraded. The general style of ornament is rather similar to that of *Kossmaticeras (K.) sakondryense*, described above, but it has a slightly smaller umbilicus (25,9 per cent vs 29,4 per cent), for which reason it is separated from the restricted form of the species.

Occurrence

Coniacian II of Zululand.

Kossmaticeras (Kossmaticeras) jonesi Collignon, 1965

Figs 6D–E, 12C–D

Kossmaticeras (Kossmaticeras) jonesi Collignon, 1965*b*: 29, pl. 426 (figs 1764–1765).

Type

The holotype, by original designation, is the original of Collignon (1965*b*, pl. 426 (fig. 1764)), from the Zone of *Kossmaticeras theobaldi* and *Barroisiceras onilahyense* of Ankinatsy-Souromaraina (Belo-sur-Tsiribihina), Madagascar.

Material

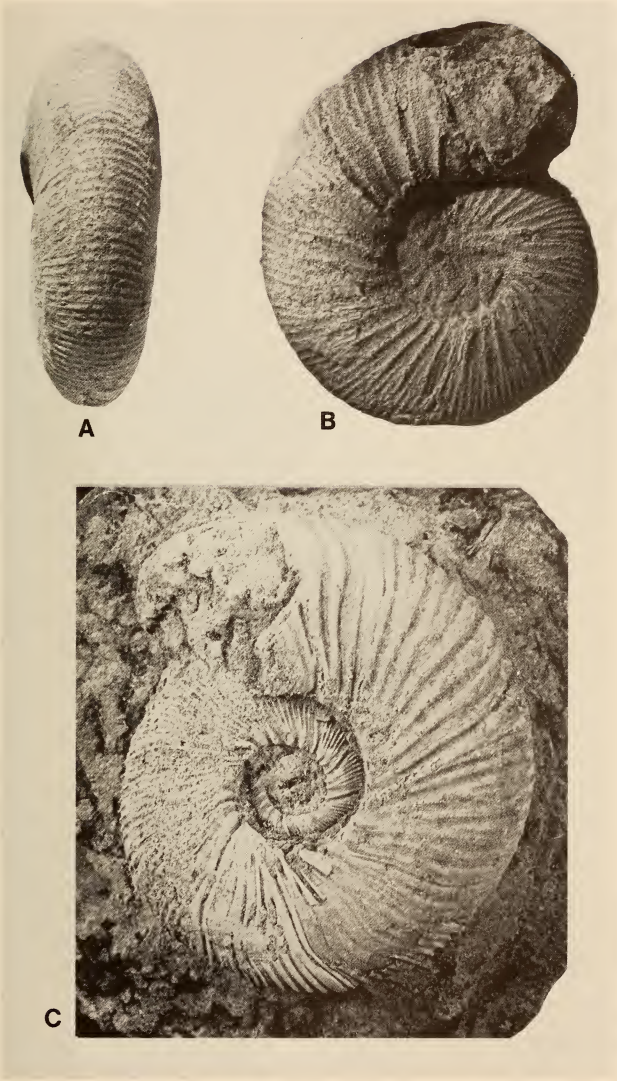
BMNH C83331 and SAS H146/7, from locality 13, hill slopes below Riverview Compound, 750 m north of the sugar-cane railway bridge across the Mfolozi, south of Mtubatuba, Zululand, St. Lucia Formation, Coniacian II.

Description

Both the specimens are fragmentary and retain either original aragonitic, or recrystallized shell material. SAS H146/7 represents an individual with an estimated adult diameter of 45 mm and a quarter of a whorl of body chamber; BMNH C83331 is a wholly septate fragment of an individual with an estimated diameter of 75 mm.

Coiling is moderately evolute, the umbilicus comprising an estimated 30 per cent of the total diameter, of moderate depth with a flattened wall, sloping outwards. The whorl section is compressed (whorl breadth to height ratio is *circa* 0,85) with the greatest breadth low on the flank or at the umbilical bullae.

Fig. 11 *(facing page)*. A–B. *Kossmaticeras (Kossmaticeras) manasoaense* Collignon, 1954; the holotype, the original of Collignon (1954, pl. 5 (fig. 1–1b)), from the Coniacian of Manasoa, Madagascar. C. *Kossmaticeras (Natalites) africanus faku* (van Hoepen, 1920); specimen in the Durban Museum cited by Spath (1921*a*: 47), from an unspecified horizon in the Umzamba Formation near the Umzamba Estuary. All × 1.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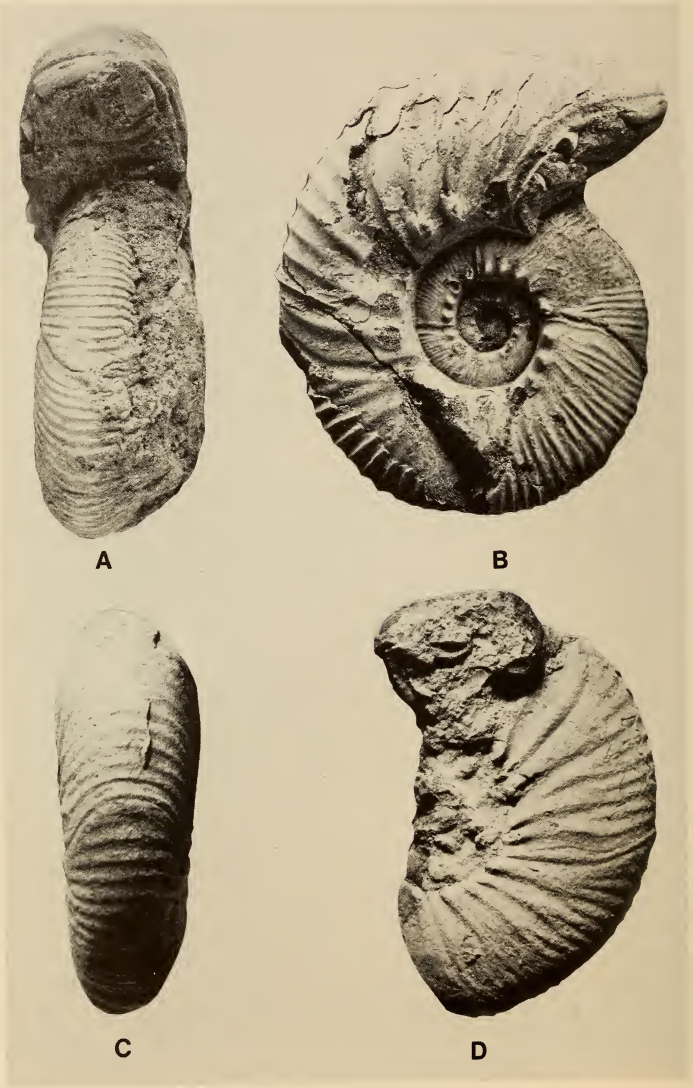
A
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D

There are numerous closely spaced umbilical bullae, of variable strength, and these give rise to single or paired ribs, which commonly bifurcate at mid-flank while shorter intercalatories are also present between primaries. The ribs are crowded, prorsiradiate and flexuous, convex at mid-flank, concave on the outer flank and projected across the venter. The constrictions are prominent, relatively strong, prorsiradiate and flexuous with associated collar-ribs; the adapical one is strong, arises from an umbilical bulla, and splits into four in typical virgatotome style; the adapertural one is simple.

The sutures are not exposed.

Discussion

The diagnostic features are the compressed whorl combined with strong, dense ribbing, the ribs branching on the outer flank, and the prominent strong constrictions. Together, these readily distinguish the species from the coarsely ribbed *Kossmaticeras (K.) sparsicostatum*, inflated *K. (K.) pachystoma*, delicately ribbed *K. (K.) sakondryense* or serpenticone and wiry-ribbed *K. (K.) theobaldianum* group. *Kossmaticeras (K.) jeletzkyi* Collignon (1965*b*: 29, pl. 426 (fig. 1766)) has not dissimilar proportions, but seven constrictions per whorl, a marked weakening of ribs at mid-flank, and numerous intercalatories. *Kossmaticeras (K.) manasoaense* and *K. (K.) virgatitiforme* all differ in having finer ribs, with individually distinctive styles and branching patterns (see Collignon 1954, 1955, 1965*b* for details).

Occurrence

Coniacian II of Zululand; Middle Coniacian of Madagascar.

Kossmaticeras (Kossmaticeras) sp. cf. *jonesi* Collignon, 1965

Fig. 6A–C

Compare

Kossmaticeras (Kossmaticeras) jonesi Collignon, 1965*b*: 29, pl. 426 (figs 1764–1765).

Material

SAS Z1587, from the St. Lucia Formation, Coniacian II at locality 92. Bulldozer scrapings and hill slopes on the farm Panplaas, ESE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian II or III.

Fig. 12 *(facing page)*. A–B. *Kossmaticeras (Natalites) africanus africanus* (van Hoepen, 1920); the holotype of *Madrasites natalensis* Spath, 1922, BMNH C19432, from an unspecified horizon in the Umzamba Formation. C–D. *Kossmaticeras (Kossmaticeras) jonesi* Collignon, 1965; BMNH C83331, from locality 13, Zululand, Coniacian II. All × 1.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z1587	37,3	12,1(32,4)	14,6(39,1)	0,83	11,9(31,9)

Description

This small specimen retains iridescent nacreous shell, and is septate to a diameter of 37,3 mm, with indications of the former presence of more than half a whorl of body chamber.

Coiling is moderately involute, the umbilicus comprising 31,9 per cent of the diameter, of moderate depth with a flattened wall and narrowly rounded shoulder. The whorl section is compressed with a breadth to height radio of 0,83, the greatest breadth being at the umbilical shoulder, the flanks flattened, convergent, with an arched venter.

There are approximately 20 variably developed umbilical bullae per whorl. These give rise to one or two primary ribs that are narrow and rather sharp. They are prorsiradiate, flexing forward across the inner flank, convex at mid-flank, thereafter curving backward into a distinct concavity before sweeping forward to pass almost straight across the venter. Some ribs bifurcate at various positions; there are also shorter intercalated ribs and occasional non-bullate primaries, giving a total of approximately 65 ribs per whorl.

There are six constrictions per whorl, marked on the shell by a strong adapical collar that branches twice, and a series of fine riblets over the site of the constrictions.

The sutures are not exposed.

Discussion

The holotype of *Kossmaticeras (Kossmaticeras) jonesi* is much larger than the present specimen (107 mm vs 37,3 mm), but it shows sufficient similarities to allow us to tentatively refer the specimen to this species.

Occurrence

St. Lucia Formation, Coniacian II or III of Zululand.

Kossmaticeras (Kossmaticeras) jeletzkyi Collignon, 1965

Fig. 9

Kossmaticeras jeletzkyi Collignon, 1965*b*: 29, pl. 426 (fig. 1766).

Type

The holotype, by original designation, is the original of Collignon (1965*b*, pl. 426 (fig. 1766)) from the Middle Coniacian of Analabe (Belo-sur-Tsiribihina), Madagascar.

Material

SAM–D1342, from locality 72, degraded cliffs and alluvial flats on north side of Mzinene River, NNE of Hluhluwe, Zululand, St. Lucia Formation, Coniacian III.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*	*Ribs*
SAM–D1342	116,5	–(–)	43,8(37,6)	–	39,0(33,5)	66

Description

The specimen is a somewhat distorted internal mould retaining extensive areas of recrystallized shell. About two-thirds of the outer whorl are body chamber.

Coiling is relatively evolute, the shallow, crater-like umbilicus comprising 33,5 per cent of the diameter with a flattened, outward-inclined wall. The umbilical shoulder is abruptly rounded, the whorl section is compressed (whorl breadth to height ratio is 0,82), with the greatest breadth at, or just outside, the umbilical bullae. The inner flanks are flattened and subparallel; the outer converge to a high arched venter.

The inner whorls are ornamented by 21 somewhat variable umbilical bullae, which give rise to one, or rarely two, straight prorsiradiate ribs which generally do not branch in the area of flank exposed.

On the outer whorl, there are 26 umbilical bullae. These give rise to broad, flexuous prorsiradiate ribs, singly or in pairs. These flex forward across the inner flank, are convex and flex backward across the mid-flank, where some branch, or are accompanied by shorter intercalated ribs. All the ribs are concave across the outer flank, and project forward over the ventrolateral shoulders to cross the venter in a broad convexity. There are seven constrictions per whorl. These are strong and deep on the internal mould, but rather less conspicuous where the shell is present. The adapical collar-rib is the stronger, bullate and bifurcates three times. The adapertural collar-rib is simple.

The sutures are not exposed.

Discussion

The distinguishing features of this species are the compressed whorl section and seven prominent constrictions on the outer whorl, thus separating it from the allied *Kossmaticeras (K.) jonesi* Collignon.

Occurrence

Lower Coniacian of Madagascar, Coniacian III of Zululand.

Subgenus *Natalites* Collignon, 1954

Type species

Madrasites natalensis Spath, 1922, by the original designation of Collignon (1954: 6) (= *Holcodiscus africanus* van Hoepen, 1920).

Kossmaticeras (Natalites) africanus africanus (van Hoepen, 1920)

Figs 12A–B; 13A–E, G–I; 16G–I; 18B–H

Holcodiscus africanus van Hoepen, 1920: 146, pl. 26 (figs 3–5); 1921: 23.
Holcodiscus africanus? van Hoepen: van Hoepen, 1921: 23.
Madrasites africanus van Hoepen: Spath, 1921*a*: 48; 1922: 135.
Madrasites natalensis (Crick MS) Spath 1922: 134, pl. 5 (fig. 3).
Kossmaticeras (Natalites) natalensis Spath: Collignon, 1954: 6; 1955: 13; 1966: 8–9, pl. 457 (fig. 1867), pl. 458 (fig. 1868). Wright, 1957: L374, fig. 490 (1).

Types

The holotype by original designation is TM 578, the specimen figured by Van Hoepen (1920, pl. 26 (figs 3–5)); paratypes are TM 543–5, all from the Umzamba Formation 'at the mouth of the Umzamba River, Pondoland', precise horizon unknown. The holotype of *Madrasites natalensis* is BMNH C19432, the specimen figured by Spath (1922, pl. 5 (fig. 3)) from an unknown horizon at the Umzamba River estuary.

Apart from the types, the specimen in the Durban Museum mentioned by Spath (1921*a*: 48) (see Fig. 16G–I), SAM–7105 and 7073, NMB D1697, and SAS Z1587 and P1416, are all from the same locality as the types.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
TM 578 (after Van H.)	44,0	*c.*12(27,3)	*c.*17(38,6)	0,71	13,5(30,7)
SAS P1416	31,8	11,2(35,2)	11,6(36,4)	0,97	11,5(36,2)
NMB D1697	59,4	18,0(30,3)	21,0(35,4)	0,86	20,5(34,5)
BMNH C19432 (after Spath)	81,0	–(34)	–(40)	0,75	–(30)

Description

Coiling is moderately evolute (approximately one-third to one-half of the previous whorl is covered) with a moderately deep umbilicus that varies between

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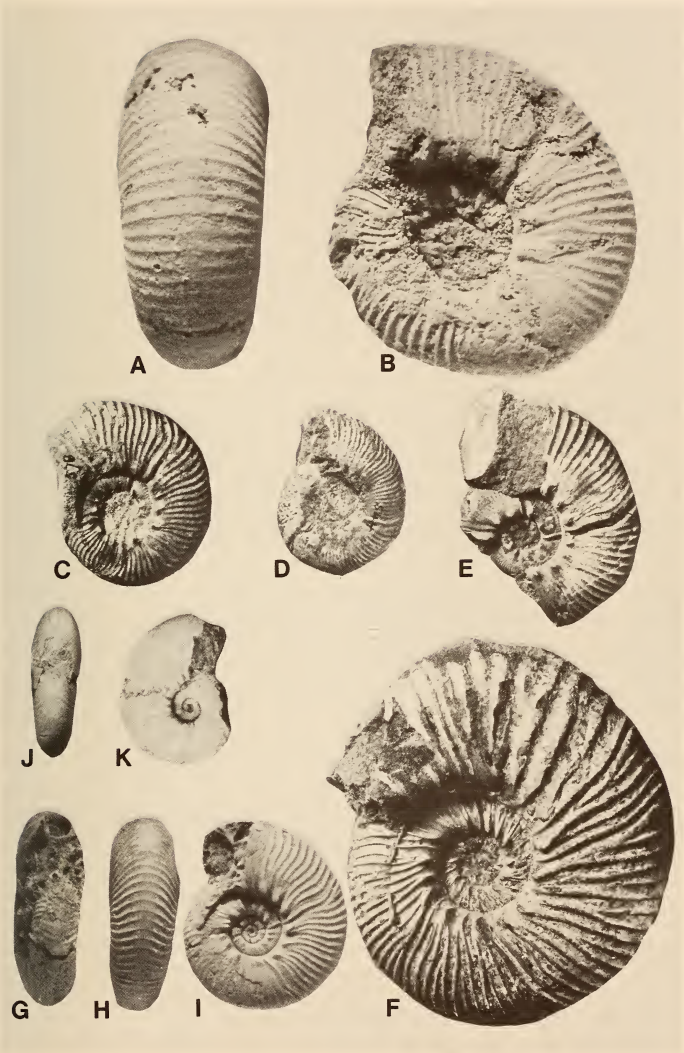
Fig. 13 *(facing page)*. A–E. *Kossmaticeras (Natalites) africanus africanus* (van Hoepen, 1920). A–B. BMNH C83335, × 3,3. C. TM 578, the holotype. D. TM 544, paratype. E. TM 544, paratype. F. *Kossmaticeras (Natalites) africanus faku* (van Hoepen, 1920); TM 543, holotype. G–I. *Kossmaticeras (Natalites) africanus africanus* (van Hoepen, 1920); SAS P1416. J–K. *Kossmaticeras (Natalites) elegans* sp. nov.; paratype, the original of Woods (1906, pl. 42, (fig. 2a–b)). All from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary. All × 1.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30 and 36 per cent of the diameter. The whorl section is generally compressed, with the greatest breadth at the umbilical bulla, and with flattened flanks that converge to a broadly arched venter. There are on average 20 comma-shaped umbilical bullae per whorl; they arise as broad swellings on the umbilical wall, and give rise to single ribs or groups of up to four ribs. These are sharp and narrow, prorsiradiate and flexuous, convex across the inner mid-flank and concave across the outer, sweeping forward over the venter in a broad convexity. There are occasional intercalatories, which do not originate in an umbilical bulla.

There are six to seven broad constrictions per whorl, flanked by collar-like ribs. The adapertural ones are usually simple and without bullae, whereas the adapical ones show virgatotome style of branching into two or three secondaries.

Ornament on the innermost whorls is generally very weak, with the constrictions very conspicuous. On the later part of the phragmocone ribbing and tuberculation become very conspicuous and bold, but weaken again on the body chamber.

Discussion

It is difficult to satisfactorily separate *Kossmaticeras (Natalites) africanus* (van Hoepen) (of which *K. (N.) natalensis* (Spath, 1922) is a synonym) from *K. (N.) faku* (van Hoepen) (of which *K. (N.) acuticostatus* (Spath, 1922) is a synonym). Both are poorly represented in terms of numbers, and little accurate stratigraphic data on their distribution is available. Generally, *K. (N.) africanus* is the more compressed, wider umbilicate form with ribs only branching at the umbilical bullae, except for the virgatotome branching at the constrictions, whereas *K. (N.) faku* has a more inflated whorl section, narrower umbilicus and abundant intercalatory and branching ribs which arise at mid-flank. However, these extreme forms are connected by numerous transitions (as already mentioned by Spath (1921*a*: 47)) so that separation at more than subspecific level would seem unnecessary. The holotypes of '*Madrasites natalensis*' Spath (Fig. 12A–B) and '*Madrasites acuticostatus*' Spath (Fig. 15A–C) illustrate the point. '*Madrasites natalensis*' has coiling similar to *Kossmaticeras (N.) africanus faku*, but ornament comparable to that of *K. (N.) africanus africanus*. '*Madrasites acuticostatus*' has coarse ribbing comparable to that of *K. (N.) africanus faku*, but it lacks the abundant mid-flank bifurcations and intercalatories, and in this respect is again closer to *K. (N.) africanus africanus*.

Occurrence

A single specimen (Klinger & Kennedy 1980) was recovered *in situ* from Bed C11 on the southern side of the Umzamba Estuary, and can be dated as Santonian III. All the other specimens are from unknown horizons in the Umzamba Formation. In Madagascar the species (as *Natalites natalensis*) was recorded from the Lower Santonian, Zone of *Texanites oliveti*. As yet, the species is unknown in Zululand.

Kossmaticeras (Natalites) africanus faku (van Hoepen, 1920)

Figs 11C, 13F, 14–15, 16A–F

Holcodiscus faku van Hoepen, 1920: 144, pl. 25 (figs 3–4), pl. 26 (figs 1–2).
Madrasites faku van Hoepen: Spath, 1921*b*: 47; 1922: 135.
Madrasites acuticostatus Spath, 1922: 134, pl. 8 (fig. 2).

Types

The holotype, by original designation, is TM 542, the specimen figured by Van Hoepen (1920, pl. 25 (figs 3–4)), and the paratype TM 579 (Van Hoepen 1920, pl. 26 (figs 1–2)), both from an unspecified horizon in the Umzamba Formation 'near the mouth of the Umzamba River' (Van Hoepen 1920: 142). The holotype by monotypy of *Madrasites acuticostatus* Spath, 1922, from the same locality and an equally uncertain horizon, is BMNH C19433.

Material

Apart from the types, the two examples from the Umzamba Formation of Pondoland, housed in the Durban Museum, mentioned by Spath (1921*b*: 47) (see Fig. 16A–F) were examined.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
Holotype TM 542	57,0	20,0(35,1)	23,0(40,3)	0,87	16,0(28,1)

Description

Coiling is moderately involute, covering more than half of the previous whorls. The whorl section is compressed, with greatest breadth near the umbilical edge, the flanks converging to a narrower, rounded venter. On the inner whorls the umbilical wall is nearly vertical, and the umbilical edge well defined. On the outer whorl the umbilical wall slants outwards and the edge becomes more rounded.

There are 18 sharp, comma-shaped umbilical bullae on the holotype. From there arise pairs or trios of sharp, narrow, sinuous ribs, many of which again bifurcate near mid-flank. Some ribs arise directly on the umbilical edge and follow a similar course over the flanks. In total there are about 80 ribs per whorl.

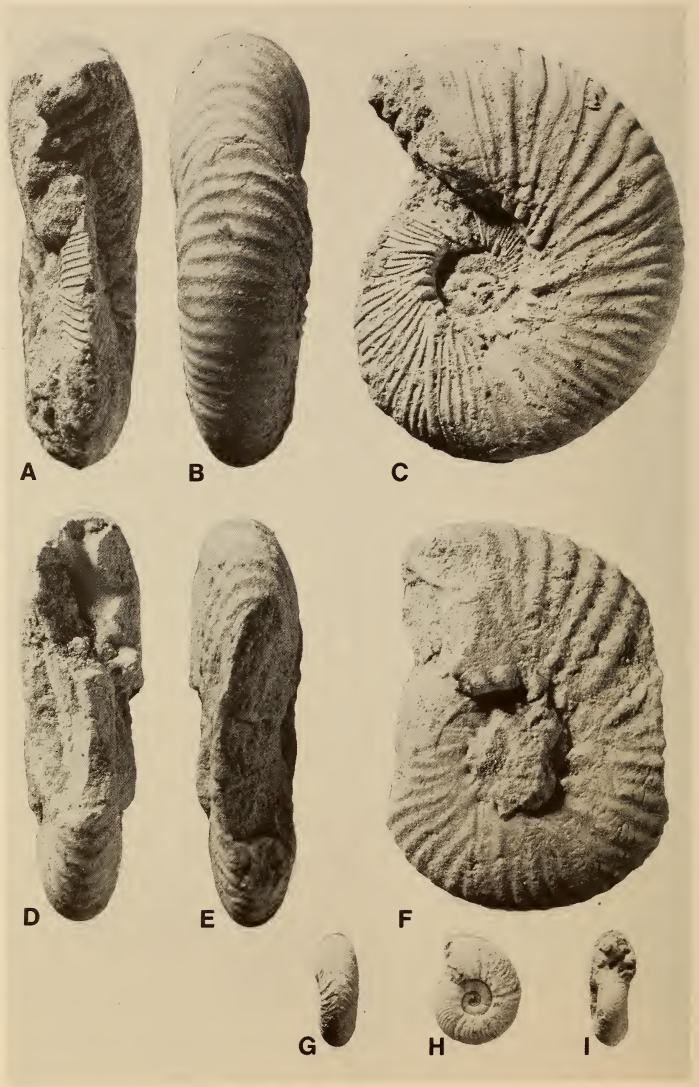
Seven distinct constrictions are present on the outer whorl of the holotype. These are already noticeable on the umbilical wall, and follow a prorsiradiate, sinuous path over the flanks, with a marked forward flexure over the venter. The rib adapical of each constriction is thickened, and shows a virgatotome style of branching into three or four secondaries. On the body chamber ribbing and umbilical ornament become weaker and more distant.

Discussion

As discussed above, separation of *Kossmaticeras (N.) africanus africanus* and *K. (N.) africanus faku* is difficult in the case of transitional forms such as the

Fig. 14. A–C. *Kossmaticeras (Natalites) africanus faku* (van Hoepen, 1920); TM 579, paratype, from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary. × 1.

Fig. 15. A–C. *Kossmaticeras (Natalites) africanus faku* (van Hoepen, 1920); BMNH C19433, the holotype of *Madrasites acuticostatus* Spath, 1921, from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary. ×1.


A
B
C
D
E
F
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H
I

holotypes of *Madrasites acuticostatus* Spath, 1922, or *Madrasites natalensis* Spath, 1922. Typical *K. (N.) faku* has abundant bifurcations at mid-flank, whereas typical *K. (N.) africanus* lacks these.

Occurrence

None of the specimens is precisely localized within the Umzamba Formation at the Umzamba Estuary, and the subspecies cannot be dated more precisely than Middle or Upper Santonian to Lower Campanian.

Kossmaticeras (Natalites) similis Spath, 1921

Fig. 17

Madrasites similis Spath, 1921*b*: 48, pl. 6 (fig. 1).

Type

The holotype by monotypy is the specimen figured by Spath (1921*b*, pl. 6 (fig. 1)) in the collections of the Durban Museum, from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary.

Material

No additional material of the species is known.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
Holotype (after Spath)	100	33(33)	38(38)	0,87	34(34)

Description

The holotype lacks the innermost whorls and is preserved as an internal mould. Coiling is moderately evolute with successive whorls embracing each other up to about mid-flank. The whorl section is higher than wide, with greatest width at the umbilical edge, and then tapers slowly to the broadly rounded venter.

Ornament on the phragmocone consists of strong, conical umbilical tubercles, and ribbing that arises either from the tubercles or intercalates. Ribbing is weak near the umbilical edge and inner part of the flank, but increases outwards across the flanks, and is at a maximum across the venter. On the outer whorl, the ribbing becomes increasingly irregular, the primary ribs arising singly or in pairs from weak to strong umbilical bullae, with occasional shorter intercalated ribs. At the greatest diameter preserved, the ribs coarsen and are blunted.

Fig. 16 *(facing page)*. A–F. *Kossmaticeras (Natalites) africanus faku* (van Hoepen, 1920); the two specimens mentioned by Spath (1921: 47) as *Madrasites faku* van Hoepen. G–I. *Kossmaticeras (Natalites) africanus africanus* (van Hoepen, 1920); the specimen mentioned by Spath (1921: 48) as *Madrasites africanus* van Hoepen. All from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary. All × 1.

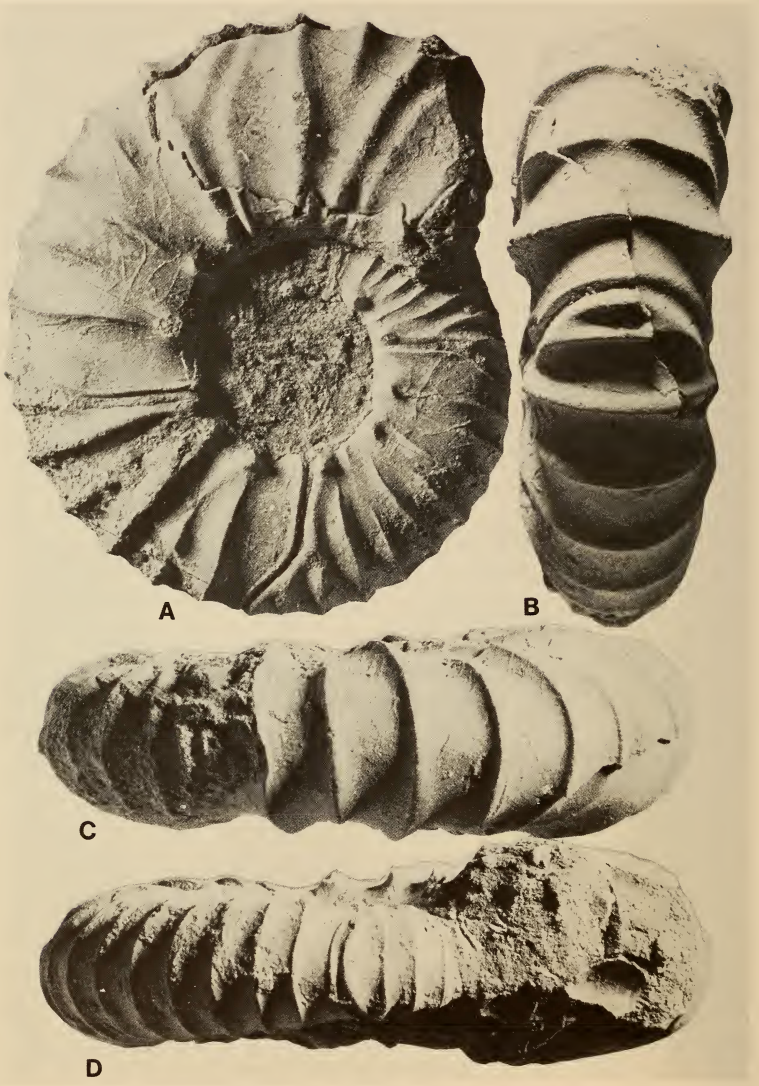


Fig. 17. A–D. *Kossmaticeras (Natalites) similis* Spath, 1921. B and C are two different ventral views of the holotype, from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary. × 1.

There are five deep constrictions per whorl, narrow where shell is present, but broad on the internal mould. They are straight and prorsiradiate across the inner and middle flank, flex abruptly forward on the outer flank and cross the venter with a linguoid apertural projection. There are flanking collars: the adapertural one is narrow and simple, without an umbilical bulla; the adapical one stronger and commonly split, virgatotome-fashion, into three riblets.

The sutures are not visible.

Discussion

The very distant, narrow strong ribs and large, distant bullae separate this species readily from all others referred to the subgenus. As Spath (1921*b*: 48) noted, *Kossmaticeras (N.) similis* stands in the same relationship to *K. (N). faku* as *K. (K.) sparsicostatum* does to *K. (K.) theobaldianum*.

Occurrence

The holotype is from the Umzamba Formation of Pondoland and is presumably of Middle or Upper Santonian to Lower Campanian age.

Kossmaticeras (Natalites) elegans sp. nov.

Figs 10C–E, 13J–K, 18A

Types

Holotype SAS H30/9, from locality 100, hill slopes alongside track leading north from Nkundusi, 1.0–1.5 km N of the village, SE of Hluhluwe, Zululand, St. Lucia Formation, Santonian I. Paratypes are SAM 13100 and 4811 (= Woods 1906, p. 336, pl. 42, (fig. 2a–b)) from an unknown horizon in the Umzamba Formation of Pondoland.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS H30/9	63.7	18.0(28.3)	23.5(36.8)	0.77	18.7(29.3)

Description

The holotype is largely septate and retains much of its nacreous aragonitic shell.

The coiling is moderately involute, 67 per cent of the previous whorl being covered. The umbilicus is of moderate breadth (29.3 per cent of the total diameter) with the umbilical wall sloping outwards, flattened, with an abruptly rounded shoulder. The whorl section is compressed (whorl breadth to height ratio is 0.77), with the greatest width at the umbilical bullae. The whorl sides are high, flattened, and converge to a narrowly rounded venter on the phragmocone that broadens on the body chamber. Broad ribs arise on the umbilical wall and give rise to 21 small comma-shaped bullae per whorl. These give rise to bundles of up to four, and occasionally five, fine prorsiradiate ribs that are straight across the

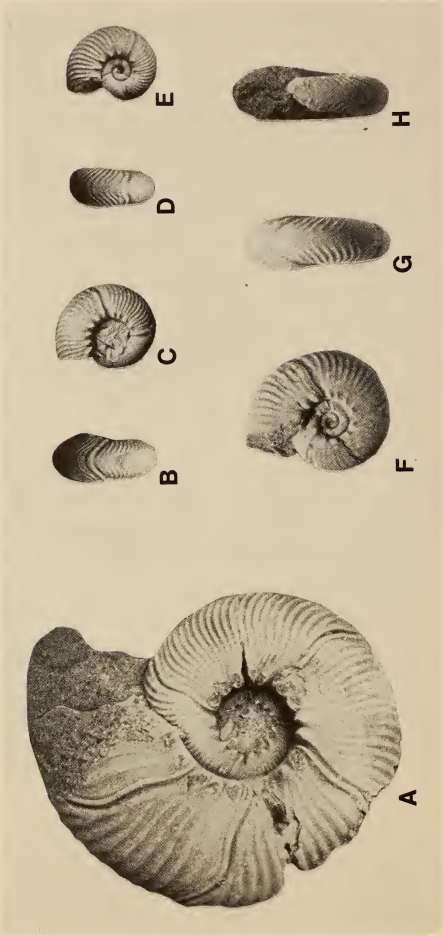


Fig. 18. A. *Kossmaticeras (Natalites) elegans* sp. nov., paratype SAM–13100, × 1. B–H. *Kossmaticeras (Natalites) africanus africanus* (van Hoepen, 1920); the paratypes TM 543–5, × 1. All from an unspecified horizon in the Umzamba Formation at the Umzamba Estuary.

inner flank but sweep backward at mid-flank and thereafter forward to project strongly over the ventrolateral shoulders, connecting across the venter in a marked convexity. On the phragmocone there is occasional secondary branching and intercalation of short ribs, while simple and intercalated ribs become common on the body chamber, to give a total of 104 ribs per whorl.

There are nine constrictions per whorl, deep on the mould and partially exfoliated specimens but much less conspicuous where shell is preserved. They are flexuous and prorsiradiate and flanked by collar-ribs. The adapertural ones lack umbilical bullae; the adapical ones are low, narrow and show a virgatotome branching into three.

The sutures are not exposed.

Remarks

The distinct umbilical bullae on the inner whorls, giving rise to groups of ribs, clearly indicate this to be a species of *Kossmaticeras (Natalites)*. It is the oldest species so far recorded. It differs from all other described species of the subgenus in its involution, compression, and high, flat-sided whorls with weak ornament throughout, all of which separate it from the other South African species. Of the various New Zealand species described by Henderson (1970), the present form most closely resembles *K. (Natalites) bensoni* Henderson (1970: 39, pl. 4 (fig. 3)). The latter is a larger form, has stronger, persistent umbilical bullae, thin, narrow ribs that are markedly flexuous, and four constrictions per whorl, rather than the nine seen in the present species.

Occurrence

St. Lucia Formation, Santonian I, locality 100, Zululand; Umzamba Formation (precise horizon unknown), Umzamba Estuary, Transkei.

Subgenus *Karapadites* Collignon, 1954
(= *Karapadites* Matsumoto, 1955)

Type species

Holcodiscus karapadensis Kossmat, 1897, by original designation of Collignon (1954).

Kossmaticeras (Karapadites) karapadensis (Kossmat, 1897)
Figs 19C–E, 24A

Holcodiscus karapadensis Kossmat, 1897: 41 (148), pl. 8 (19) (figs 2, 4).
Karapadites karapadensis Kossmat: Collignon, 1954: 27, pl. 6 (figs 1–4); 1955: 27, pl. 6 (figs 1–4); 1969: 69, pl. 541 (fig. 2121).

Types

Kossmat (1897) based this species on two specimens from the Arialoor Group of Karapady, southern India, in the Warth Collection. The larger specimen figured by him as plate 8 (19) (fig. 4a–c) is herein designated lectotype.

Material

BMNH C83328 from locality 14, road cuttings below the compound immediately south of the Msunduzi River, 2,1 km NNE of Mfolozi, south of Mtubatuba, Zululand, St. Lucia Formation, Campanian I.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
BMNH C83328	33,8	–(–)	12,0(35,5)	–	11,3(33,4)
at	28,9	9,9(34,3)	9,6(33,2)	1,03	10,5(27,5)

Description

The specimen is a wholly septate internal mould. Coiling is evolute, less than a third of the previous whorl being covered. The umbilicus comprises 27,5 per cent at a diameter of 28,9 mm, becoming more evolute with growth (33,4 per cent at 33,8 mm).

The whorl section is slightly wider than high with the greatest breadth low on the flank; the sides are flattened, converging to an arched venter. There are 15 small umbilical bullae per whorl. These give rise to groups of three ribs, almost invisible on the inner flank, but strengthening across the mid- to outer flank, where they are joined by intercalated ribs. All are distinctly flexuous and prorsiradiate, crossing the venter (over which they weaken) in a shallow convexity. There is a total of 60 ribs per whorl.

Four prominent, strong, deep constrictions are present on the outer whorl. They are concave and markedly prorsiradiate, crossing the venter with a narrow linguoid adapertural projection; they weaken over the siphonal line. The associated adapical collar rib is strong, arises from an umbilical bulla and bifurcates twice. The adapertural rib is weaker.

The suture-line is shown in Figure 24A, and agrees closely with that of the lectotype.

Discussion

The single small specimen of *Kossmaticeras (Karapadites) karapadensis* agrees well with Kossmat's type material, and Madagascan specimens illustrated by Collignon (1954, 1969). The species is distinguished from *Kossmaticeras (Karapadites) madrasinus* (Stoliczka, 1865) (p. 139, pl. 70 (figs 1–3)) by the stronger ribs, well developed on the flank, stronger umbilical bullae, plus six to eight prominent constrictions per whorl; features differentiating adults are given by Collignon (1954: 31–32).

Adult *Kossmaticeras (Karapadites) besairiei* Collignon (1954: 29, pl. 8 (fig. 2); 1969: 68, pl. 540 (fig. 2116)) (see Fig. 20) are coarser ribbed, the ribs less crowded and the constrictions flexuous, rather than straight. On the mature body chamber the ribs are strong, distant, branching twice, with deep interspaces and strong umbilical bullae. According to Collignon (1954: 30), however, the

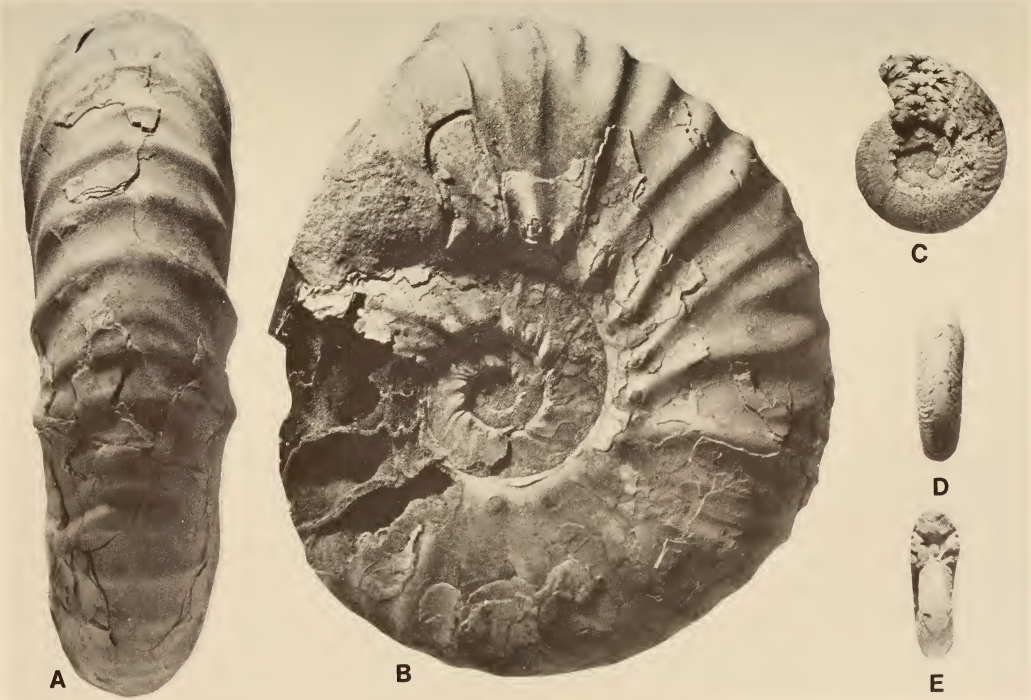


Fig. 19. A–B. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966; SAS KK105b, from locality 105, Zululand, Santonian III or Campanian I. ×0,85. C–E. *Kossmaticeras (Karapadites) karapadensis* (Kossmat, 1897); BMNH C83328, from locality 14, Zululand, Campanian I. × 1.

juveniles of *K. (K.) karapadensis* and *K. (K.) besairiei* grade into each other. *Kossmaticeras (Karapadites) rabenjanaharyi* Collignon (1954: 33, pl. 7 (fig. 2); 1969: 69, pl. 541 (fig. 2119)) is a distinctive late form with coarser, distant ribs.

Kossmaticeras (Karapadites) hourcqui Collignon (1954: 34, pl. 10 (figs 1–2); 1969: 68, pl. 540 (fig. 2117)) has bullate umbilical nodes that give rise to strong ribs. *Kossmaticeras (Karapadites) lateconstrictus* Collignon (1969: 69, pl. 541 (fig. 2122)) is in contrast characterized by dense and crowded ribs, more numerous umbilical bullae, and striking broad constrictions on the body chamber.

Several of these species co-occur in Madagascar, and it is debatable whether all merit specific separation. With the present poor material it is not possible to speculate further.

The Santonian *Kossmaticeras (Karapadites) planissimus* Collignon, 1966 (p. 88, pl. 491 (fig. 1976)) is highly distinctive (see below), with a much more marked loss of flank ribs on the nuclei than most later forms and a much stronger, coarser and more irregular ornament which readily separates it from the present species.

Occurrence

The types are from southern India; in Madagascar the species characterizes a Lower Campanian horizon some way above the base of the stage. The single Zululand specimen comes from Campanian I.

Kossmaticeras (Karapadites) cf. *madrasinus* (Stoliczka, 1865)

Figs 23D–E

Compare

Ammonites madrasinus Stoliczka, 1865: 139, pl. 70 (figs 1–3).

Karapadites madrasinus Stoliczka: Collignon, 1954: 31, pl. 6 (fig. 5), pl. 7 (fig. 1); 1955: 30, pl. 6 (fig. 5), pl. 7 (fig. 1), pl. 8 (fig. 1); 1969: 69, pl. 541 (fig. 2120).

Material

SAS KK105C/1, from locality 105, cliff sections 3,5 km north of the Nyalazi River estuary, ESE of Hluhluwe, Zululand, St. Lucia Formation, imprecisely localized in the range Santonian III–Campanian I.

Description

The Zululand specimen is a rather poorly preserved, composite internal mould of the body chamber of an individual with an estimated original diameter of *circa* 75 mm. The coiling appears to have been moderately involute with a small umbilicus (estimated at approximately 30 per cent of the diameter). The whorl section is compressed (whorl breadth to height ratio is 0,68 to 0,70), with the greatest breadth low on the flanks, the sides slightly rounded, converging to a narrow rounded venter.

Ornament consists of numerous small comma-shaped umbilical bullae that give rise to single ribs and pairs of ribs. These are dense, crowded, flexuous, prorsiradiate, branch into pairs of secondaries at or about mid-flank, and are accompanied by shorter intercalatories. There are periodic poorly preserved constrictions.

The sutures are not decipherable.

Discussion

Of described species, this fragment compares best with *Kossmaticeras (Karapadites) madrasinus* by virtue of compression of whorls, crowded ribs and bullae. It especially resembles the specimen illustrated by Collignon (1954, pl. 7 (fig. 2)).

Occurrence

Imprecisely localized in the range Santonian III–Campanian I of Zululand. The types are from southern India. At Menabe, Madagascar, it characterizes the Lower Campanian *Karapadites karapadensis* Zone, *Hourcquiella bererensis* subzone.

Kossmaticeras (Karapadites) besairiei Collignon, 1954

Figs 20, 22

Karapadites besairiei Collignon, 1954: 29, pl. 7 (fig. 3), pl. 8 (fig. 2); 1955: 28, pl. 7 (fig. 3), pl. 8 (fig. 2); 1969: 68, pl. 590 (fig. 2116).

Material

SAS Z1151, from locality 105, cliff section 3,5 km north of the Nyalazi River estuary, ESE of Hluhluwe, Zululand, St. Lucia Formation, imprecisely localized in the range Santonian III–Campanian I.

Dimensions

		D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z1151	*c*	96,0(100)	28,5(29,6)	34,3(35,7)	0,83	32,0(33,3)
	ic		28,0(29,1)	34,3(35,7)	0,82	
at	*c*	75,6(100)	23,8(31,5)	28,3(37,4)	0,84	25,3(33,4)
	ic		21,6(28,5)	28,3(37,4)	0,76	

Description

The specimen is a largely septate internal mould retaining only a quarter of a whorl of body chamber and traces of the original aragonitic shell.

The coiling is moderately evolute, just over 40 per cent of the previous whorl being covered. The umbilicus comprises 33 per cent of the diameter with a flattened, outward-sloping umbilical wall and abruptly rounded shoulder. The whorl section is compressed (whorl breadth to height ratio varies from 0,76 to

Fig. 20. *Kossmaticeras (Karapadites) besairiei* Collignon, 1954; paratype, the original of Collignon (1954, pl. 7 (fig. 3)), from Berere, Madagascar. × 1.

0,84), with the greatest breadth at the umbilical bullae or at the shoulder in intercostal section. The flanks are flattened and subparallel in intercostal section, with a flattened, evenly rounded venter.

There are 20 strong comma-shaped umbilical bullae per whorl. These give rise to pairs of, or single strong, distant rounded prorsiradiate ribs. These are straight to feebly convex on the inner flank, feebly concave across the outer flanks and shoulder and swing forwards across the venter, strengthening as they do so, only to weaken over the siphonal area. Many of these ribs branch and loop across the venter from various points on the flank while there are also shorter intercalatories, giving a total of 55 to 60 ribs per whorl.

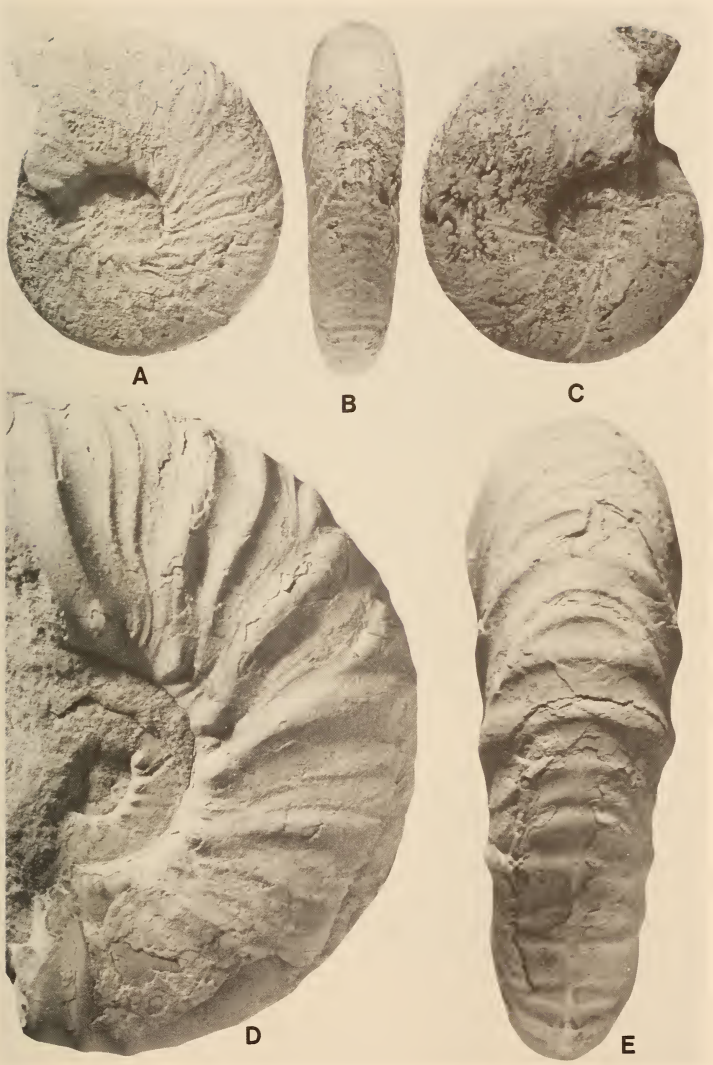


Fig. 21. A–C. *Kossmaticeras (Kossmaticeras)* aff. *sakondryense* Collignon, 1954; SAS Z934, from locality 93, Zululand, Coniacian II. D–E. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966; SAS KK105B, from locality 105, Zululand, Santonian III or Campanian I. All × 1.

Fig. 22. *Kossmaticeras (Karapadites) besairiei* Collignon, 1954; SAS Z1151, from locality 105, Zululand, Santonian III or Campanian I. × 1.

There are six strong, broad and deep constrictions per whorl on the mould, flanked by collar-ribs. The adapertural collar is usually simple, with a weak or no umbilical bulla. The adapical collar splits into three secondary virgatotome ribs.

The suture-line is as in *Kossmaticeras (Karapadites) planissimus*, described below.

Discussion

This magnificent specimen compares well with the holotype (Collignon 1954, pl. 8 (fig. 2)), and the body chamber paratype (Collignon 1954, pl. 7 (fig. 3)), reillustrated here as Figure 20, showing the same distinctive strong bullae, distant ribs, effaced on the inner flank but strong on outer flank and venter, and similar constrictions and associated collar-ribs. The variety *Kossmaticeras (Karapadites) planissimus bererensis* Collignon (1954: 31, pl. 9 (fig. 1)) is even more coarsely and strongly ribbed.

Occurrence

Lower Campanian *Kossmaticeras (Karapadites) besairiei* Zone of Menabe, Madagascar, especially the *Hourcquiella bererensis* subzone. Santonian III or Campanian I of Zululand.

Kossmaticeras (Karapadites) planissimus Collignon, 1966

Figs 1A, 19A–B, 21D–E, 23A–C, 24B, 25–26

Karapadites planissimus Collignon, 1966: 38, pl. 541 (fig. 1976).

Types

The holotype, by original designation, is the original of Collignon (1966: 88, pl. 541 (fig. 1976)), from the Upper Santonian *Pseudoschloenbachia umbulazi* Zone of Collignon's (1969) locality 692, Ampamba-Antsirasira (Belo-sur-Tsiribihina), Madagascar. There are 11 other, unfigured paratypes.

Material

SAS KK105, 105B, Z1954 and SAS H126 A/3, from locality 105, cliff section 3,5 km north of the Nyalazi River estuary, St. Lucia Formation, Santonian III or Campanian I, Zululand.

YPM 1071, from 'Port Natal'—the specimen shows signs of water wear, and may be from the Umzamba Formation of southern Natal or of the Transkei.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z1954	104,0(100)	36,5(35,1)	40,8(39,2)	0,90	25,8(34,4)
SAS KK105B	113,7(100)	38,0(33,4)	43,5(38,2)	0.87	36,4(32,0)
SAS H126A/3	114,0(100)	36,0(31,5)	43,2(37,9)	0,83	36,5(32,0)
SAS KK105	141,0(100)	42,5(30,1)	51,0(36,2)	0,83	46,5(33,0)

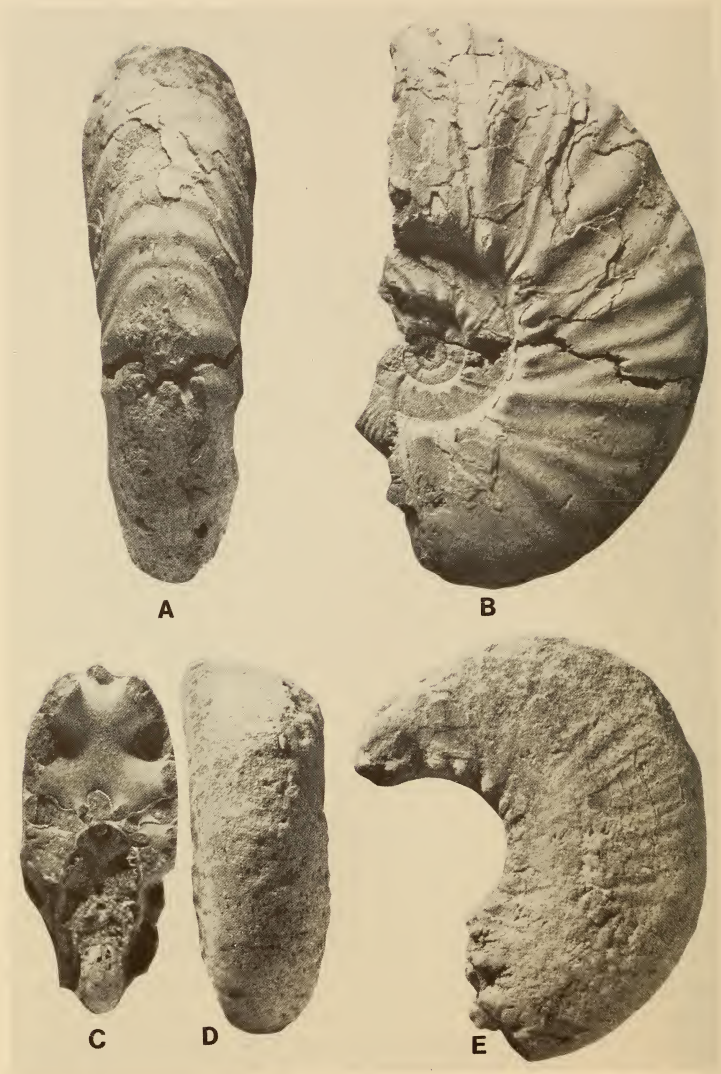


Fig. 23. A–B. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966; SAS Z1954. C–E. *Kossmaticeras (Karapadites)* cf. *madrasinus* (Stoliczka, 1865); SAS KK H105C/1. Both from locality 105, Zululand, Santonian III or Campanian I. All × 1.

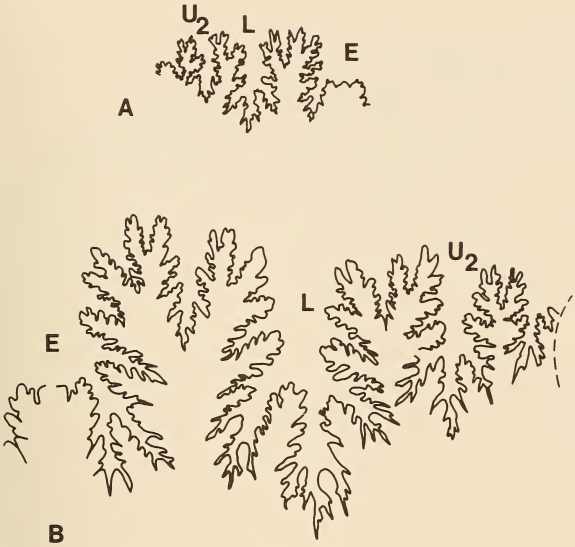


Fig. 24. External sutures of: A. *Kossmaticeras (Karapadites) karapadensis* (Kossmat, 1897), BMNH C83328; B. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966, SAS KK105B. Both × 2.

Description

The material available is generally well preserved and in the form of both moulds and specimens retaining the original aragonitic shell.

SAS Z1954 shows the early growth stages, at a diameter of 18,5 mm (Fig. 23A–B). The coiling is moderately involute (48 per cent of the previous whorl is covered), the whorl section depressed (whorl breadth to height ratio is 1,1). Ornament consists of umbilical bullae only on the internal mould (the shell is not preserved at this diameter). There are four to five strong constrictions per half whorl. They are broad, deep, prorsiradiate, straight on the flanks, and projected forward over the ventro-lateral shoulders into a narrowly rounded ventral convexity. Each has a narrow rib on the adapertural side, and this is followed by a second, shallower constriction. A highly distinctive growth-stage follows this and extends to the beginning of the outer whorl at an estimated diameter of 60 mm. The umbilicus is thus shallow, the umbilical wall slopes outward and is flattened, with an abruptly rounded umbilical shoulder. All those parts of the flanks not

Fig. 25. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966; specimen No 1071 in the Peabody Museum, Yale University, from 'Port Natal'. ×0,75.

Fig. 26. *Kossmaticeras (Karapadites) planissimus* Collignon, 1966; specimen No 1071 in the Peabody Museum, Yale University, from 'Port Natal'. × 1.

concealed by the succeeding whorls are flat. There are 16 to 19 strong comma-shaped umbilical bullae of variable strength that give rise to single or paired, markedly prorsiradiate ribs. These decline markedly on the inner to mid-flank which in some specimens (e.g. YPM 1071, see Figs 25, 26) are almost smooth. The ribs flex back across the outer flank, where they are concave and

accompanied by intercalated ribs and may branch before sweeping forward across the venter, where they are at their strongest. There are up to eight constrictions per whorl.

All the available specimens are adult, with diameters of up to 140 mm and up to two-thirds of a whorl of body chamber. At mature growth-stages, at shell diameters exceeding 60 mm, the coiling becomes increasingly evolute and the umbilicus widens to comprise up to 34 per cent of the diameter. The umbilical wall is of moderate height, is flattened, and slopes outward, giving a shallow crater-like form to the adult umbilicus. The whorls are compressed (whorl breadth to height ratio is as little as 0,83), with the greatest breadth at the umbilical bullae. The flanks are compressed, subparallel to slightly convergent with a broadly rounded venter. There are up to 20 strong to weak, variable umbilical bullae per whorl. These give rise to single, or pairs of, ribs on the last part of the phragmocone and predominantly single ribs on the body chamber. The ribs are strong, broad, rounded, prorsiradiate and gently flexuous, pass straight across the inner flank, are convex at mid-flank, and sweep back across the outer flank, where they are concave, before sweeping forward to pass across the venter with a slight convexity. Some ribs strengthen markedly and branch high on the flank, looping across the venter, while there are occasional intercalated ribs, giving a total of 60 per whorl.

SAS H126A/3, KK105 and YPM 1071 all show the adult aperture, which is preceded by a final section of shell ornamented by dense, simple, fine flexuous ribs and growth striae, lacking bullae. The mouth border itself appears to have been simple.

Adult growth-stages appear to have had five or six constrictions per whorl, but these are much less conspicuous and relatively shallower than on the inner whorls, especially where the shell is lacking. The associated collar-ribs are, however, highly distinctive. The adapical one is strong, bullate, and bifurcates over the venter, and the adapertural branch develops a much more narrowly rounded convexity than the adapical branch. The adapertural collar is, by contrast, much weaker, simple, unbranched, narrower, and lacks a bulla.

The suture-line is shown in Figure 24B.

Discussion

Kossmaticeras (Karapadites) planissimus is the only species of the subgenus so far recorded from the Santonian. Flat sides, feeble flank ornament when young plus very coarse, distant ribs of irregular length and branching make it immediately distinctive and easily separated from all other species.

Occurrence

Upper Santonian, *Pseudoschloenbachia umbulazi* Zone of Menabe, Madagascar; Santonian III or Campanian I of Zululand and probably also the Transkei (Umzamba Formation) where it is of Middle Santonian or Lower Campanian age.

Genus *Maorites* Marshall, 1926

Type species

Kossmaticeras tenuicostatum Marshall, 1917: 445, text-fig. 3, pl. 33 (fig. 1).

Maorites cf. *subtilistriatus* Collignon, 1954

Figs 27–28

Compare

Maorites subtilistriatus Collignon, 1954: 38, pl. 11 (fig. 3); 1969: 72, pl. 442 (fig. 2124).

Types

The holotype is the original of Collignon (1954, pl. 11 (fig. 3)), from the Lower Campanian of Berere, Madagascar, refigured here as Figure 29. There are two unfigured paratypes (Collignon 1954: 38).

Material

Two specimens only: SAS Z709 from the Nibela Peninsula, Zululand, St. Lucia Formation, probably Campanian II or III; BMNH C83332 from bed 18, locality 110 on the Nibela Peninsula, St. Lucia Formation, Campanian III.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z709 at	134,0	43,2(32,2)	62,3(46,5)	0,69	30,9(23,1)

Description

The two specimens are rather poorly preserved. BMNH C83332 is largely septate with an estimated maximum preserved diameter of 105 mm. It is in part an internal mould, in part bearing recrystallized and overgrown shell that hides much of the detail of the ornament. SAS Z709 is similarly overgrown but appears to be adult, with more than half a whorl of body chamber. The estimated adult diameter must have approached 160 mm.

The coiling is moderately involute, about 60 per cent of the previous whorl being covered. The umbilicus comprises 23 per cent of the diameter and is of moderate depth; the umbilical wall is flattened and at 90 degrees to the flank of the preceding whorl. The whorls are compressed (whorl breadth to height ratio is 0,69). The greatest breadth is at the umbilical shoulder, from which the flattened flanks converge slightly to a broadly rounded, somewhat flattened venter.

On BMNH C83332, the internal mould shows an ornament of dense, flexuous prorsiradiate ribs. On the test, where preserved, they are stronger, with steep sides and distinctly flattened tops. They are narrow at the umbilical shoulder but broader and flatter across the flanks and ventrolateral shoulders. On the venter, which they pass straight across, they are at their strongest

Fig. 27. *Maorites* cf. *subtilistriatus* Collignon, 1954; SAS Z709, from the Nibela Peninsula, Zululand, probably Campanian II or III. × 0,85.

Fig. 28. *Maorites* cf. *subtilistriatus* Collignon, 1954; BMNH C83332, from locality 110, Zululand, Campanian III. × 1.

development; they are weaker and rounded on the mould but flattened and bar-like, with narrower slot-like interspaces, where the test is preserved. They increase progressively in strength as the diameter increases in the smaller specimen but on the body chamber of SAS Z709 they show a marked strengthening over the last quarter whorl. There is occasional branching at various points on the flank.

There are periodic narrow, flexuous, prorsiradiate constrictions that are most obvious on the internal mould, where they are strongest over the umbilical shoulder. In BMNH C83332 there are an estimated ten per whorl, associated with broad collars on the mould. It is not clear whether or not they truncate ribs. In SAS Z709 constrictions are again well developed and appear to be associated with stronger collars where the shell is preserved.

Fig. 29. *Maorites subtilistriatus* Collignon, 1954; the holotype, the original of Collignon (1954, pl. 9 (fig. 3–3a)), from the Lower Campanian of Berere, Madagascar. × 1.

The suture-line is partially exposed on BMNH C83332, and is deeply and intricately subdivided.

Discussion

Howarth (1966) has suggested that *Maorites subtilistriatus* from Madagascar (and now Zululand), and *M. tenuicostatus* from New Zealand (see Henderson 1970: 50, pl. 9 (figs 3–4), pl. 10 (fig. 2)) are synonyms of the equally finely-ribbed *M. densicostatus* (Kilian & Reboul, 1909) (p. 30, pl. 15 (fig. 4), pl. 18 (fig. 1)) from Antarctica. Henderson (1970) points out that *M. tenuicostatus* retains fine ribs to a large size, but admits that juvenile *M. tenuicostatus* and *M. densicostatus* are probably inseparable. Our material is too poor to resolve the problem, so we use the Madagascan name, although suspecting that but a single full species is present. Indeed, so subtle are intraspecific differences in *Maorites* that, given large populations and clear recognition of dimorphism, there can be little doubt that only a few species could be reasonably maintained.

Maorites multiconstrictus Henderson, 1970 (p. 51, pl. 9 (fig. 2)) is distinguished by coarse flexuous ribs with far more constrictions, and distinctive ontogenetic changes. *Maorites angulocostatus* Henderson, 1970 (p. 52, pl. 10 (fig. 1)) has much stronger bullae and distant, sickle-shaped fine ribs. *Maorites mackayi* (Hector, 1886) (Henderson 1970: 53, pl. 10 (fig. 3)) is a poorly known species most easily recognized by the wide spacing of the fine ribs. *Maorites seymourianus* (Kilian & Reboul, 1909) (p. 29, pl. 19 (fig. 1)) is distinguished most readily by the stronger umbilical bullae. *Maorites menabensis* Collignon, 1954 (p. 37, pl. 11 (fig. 2)) is a rather broad-whorled species with regularly dichotomous ribs. *Maorites tuberculatus*, Howarth, 1958 (p. 11, pl. 2 (figs 1–3)) is immediately distinguishable by the strongly rounded whorls, deep, broad constrictions and large umbilical bullae. *Maorites pseudobhavani* Spath, 1953 (p. 25, pl. 6 (figs 7–9)) is an evolute, robust but diminutive species with strong umbilical bullae that give rise to groups of ribs; it should be referred to *Gunnarites* (fide Howarth 1966: 67). *Maorites kandi* (Stoliczka, 1865) (p. 140, pl. 70 (fig. 4)) is more evolute with lower, slowly expanding whorls. The ribs are coarser, and show marked irregularity and become widely spaced at the aperture. *Maorites aemilianus* (Stoliczka, 1865) (p. 141, pl. 70 (figs 6–8)) is characterized by elongate bullae, and the ornament of fine ribs arranged in bundles is distinctive. *Maorites magnumbilicatus* Collignon, 1954 (p. 40, pl. 12 (fig. 1)) is a more evolute, massively whorled species with a deep umbilicus; ornament is initially of fine, crowded, slightly flexuous ribs which become strong and straight on the beginning of the body chamber, thereafter disappearing to leave the greater part of the body chamber smooth, according to Collignon (1954: 40).

Occurrence

Maorites subtilistriatus characterizes the *Maorites aemilianus* subzone of the *Karapadites karapadensis* Zone in the Lower Campanian of Menabe, Madagascar.

Genus *Gunnarites* Kilian & Reboul, 1909

Type species

Olcostephanus antarcticus Weller, 1903: 4, by the subsequent designation of Diener (1925: 101).

Gunnarites antarcticus (Weller, 1903)

Figs 30–33, 34D–E

Olcostephanus antarcticus Weller, 1903: 4, pl. 2 (figs 1–2).
Gunnarites antarcticus Stephen Weller: Diener, 1925: 101 (with synonymy). Spath, 1953: 29, pl. 3 (fig. 5), pl. 4 (fig. 9), pl. 6 (figs 1–2, 4–5), pl. 11 (fig. 1). Wright 1957: 374, fig. 490 (4). Howarth, 1966: 66 et seq.. Lahsen & Charrier, 1972: 529, pl. 1 (figs 4–6).
Gunnarites antarcticus Weller, var. *monilis* Spath, 1953: 31, pl. 6 (fig. 3).
Gunnarites antarcticus Weller, var. *inflata* Kilian & Reboul: Spath, 1953, pl. 7 (fig. 1), pl. 8 (fig. 8).
Gunnarites gunnari Kilian & Reboul: Spath, 1953: 33, pl. 5 (figs 4–5) (with synonymy).
Gunnarites pachys Spath, 1953: 34, pl. 9 (figs 1–3) (including var. *media*).
Gunnarites flexuosus Spath, 1953: 35, pl. 3 (figs 3–4), pl. 9 (figs 4–5).
Gunnarites rotundus Spath, 1953: 36, pl. 12 (figs 1–3) (including varieties *kalikaformis* and *compressa*).
Gunnarites paucinodatus Spath, 1953: 37, pl. 7 (fig. 4).
Gunnarites aff. *G. antarcticus* (St. W.): Blasco de Nullo, Nullo & Proserpio, 1980: 487, pl. 5 (figs 9–10).

Material

BMNH C83336, from the St. Lucia Formation, Campanian III at locality 115; BMNH C83334, St. Lucia Formation, Maastrichtian a (= 'Campanian' IV), locality 113. SAS Z224/1 and an unregistered and unlocalized specimen in the South African Geological Survey Collections are also referred to the species.

Dimensions

	D	*Wb*	*Wh*	*Wb:Wh*	*U*
SAS Z224/1	130,0	38,8(29,8)	55,0(42,3)	0,71	40,3(31)
BMNH C83334	108,5	36,3(33,5)	45,5(41,9)	0,80	36,5(33,6)

Description

The best-preserved specimen is BMNH C83334, represented by a well-preserved external mould, a whorl of septate phragmocone and the beginning of the body chamber. Coiling is moderately involute, 56 per cent of the previous whorl being covered. The umbilicus comprises between 31 and 33,6 per cent of the diameter and is of moderate depth with a subvertical wall. The whorl section of all our specimens is compressed (breadth to height ratio varies from 0,71 to 0,80, with the greatest breadth at, or close to the umbilical bulla). The whorl sides are flattened and convergent, the venter broadly and evenly rounded.

There are 18 strong, sharp umbilical bullae per whorl, projected into the umbilicus. These give rise to groups, generally of three ribs, while one or two

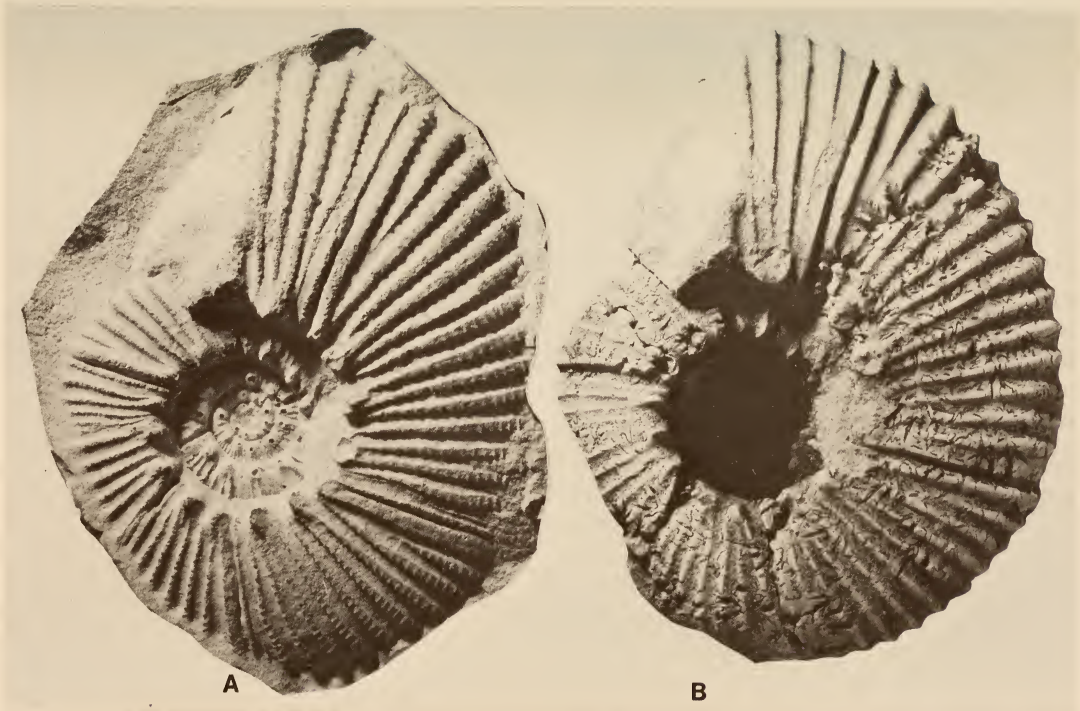


Fig. 30. A–B. *Gunnarites antarcticus* (Weller, 1903). A. Silicone cast from an external mould. B. Internal mould, BMNH C83334, from locality 115, Zululand, Maastrichtian a. × 1.

Fig. 31. *Gunnarites antarcticus* (Weller, 1903); BMNH C83334, from locality 115, Zululand, Maastrichtian a. × 1.

Fig. 32. *Gunnarites antarcticus* (Weller, 1903); BMNH C83334, from locality 115, Zululand, Maastrichtian a. × 1.

non-bullate ribs extend to the umbilical shoulder between these groups. Shorter, intercalated ribs arise around mid-flank. The ribs are initially narrow, but broaden over the venter, are flat-topped, prorsiradiate and straight or feebly flexuous, totalling over 60 per whorl. All are strongly denticulate, the spiral denticulations most prominent on the shell over the ventrolateral and ventral regions.

There are six narrow, deep constrictions per whorl, preceded by a thickened rib, and followed by a broad interspace, sometimes with associated rather feeble riblets.

The deeply incised suture-line (Fig. 31) is typically kossmaticeratid.

Fig. 33. *Gunnarites antarcticus* (Weller, 1903); BMNH C83336, from locality 115, Zululand, Maastrichtian a. × 1.

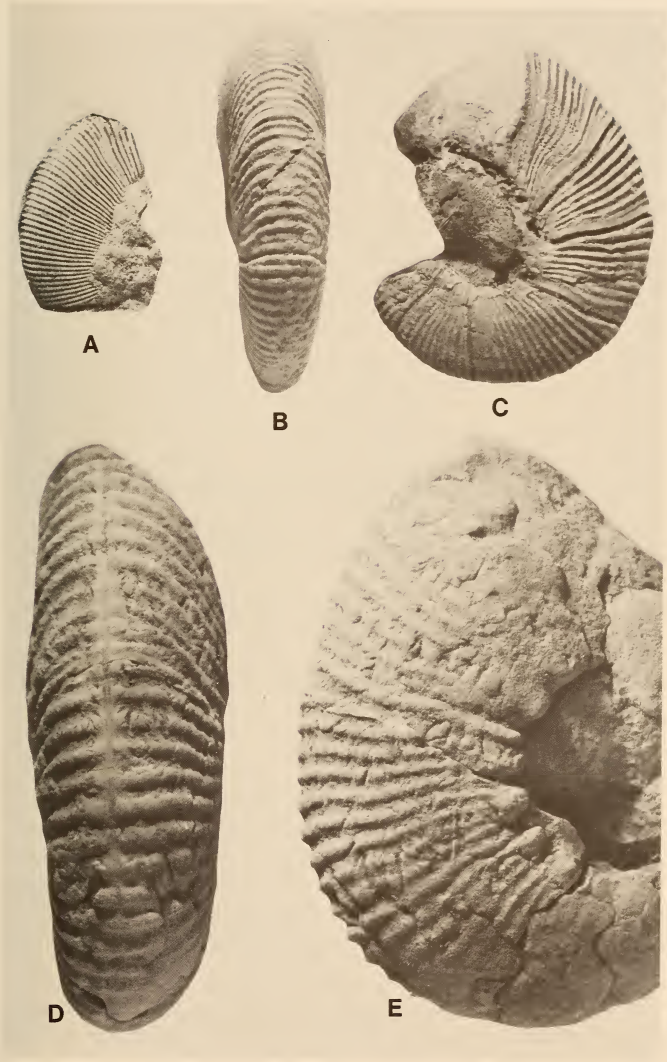
Discussion

Howarth (1966) has pointed out the intergrading relationship between all the Antarctic species of *Gunnarites* described by Spath (1953), and examination of the Antarctic material suggests there are only two forms, the large *G. antarcticus* and small *G. kalika* (Stoliczka, 1865). We strongly suspect these to be dimorphs, but cannot fully prove it at this time, so that they are maintained as separate here.

Of the various forms described from Antarctica, the specimens described here most closely recall the specimen figured by Spath (1953) as his plate 4 (fig. 9a–b).

Gunnarites antarcticus differs very clearly from the various New Zealand species described and discussed by Henderson (1970). Thus *G. zelandicus*

Fig. 34 *(facing page)*. A–C. *Gunnarites kalika* (Stoliczka, 1865). A. SAM–PCO5907, from the offshore Alphard Group (figured by Klinger, Kauffman & Kennedy, 1980, fig. 6A–B). B–C. An unregistered specimen in the South African Geological Survey Collections. D–E. *Gunnarites antarcticus* (Weller, 1903), an unregistered specimen in the South African Geological Survey Collections. All × 1.


A
B
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